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MBA PROFESSIONAL REPORT

Pacific Fleet Regional Inventory Stocking Model (PRISM)

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June 2003

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13. ABSTRACT *(maximum 200 words)*

This following project describes and assesses the current inventory-stocking model used by Commander Submarine Pacific (CSP) to manage its SSN repair parts stocking levels during a deployment work-up period. We also introduce a proposed demand based inventory management tool called Pacific Regional Inventory Stocking Model (PRISM), and compare it with the model currently being used within CSP.

This analysis will then evaluate the effectiveness of each system as a management tool utilizing data from CSP's SSN-688 Fast-Attack Submarines. Decision criteria estimated are operational readiness and cost. The results of this comparison also demonstrate a management tool that optimizes inventory stocking. This will increase an SSN-688 submarine's operational readiness while on station and potentially achieve cost savings through optimizing onboard inventory.

Recommendations will be provided, based on the results of the comparison, with respect to the feasibility of implementing PRISM, maintaining CSP's current stocking system, or developing a new submarine stocking system to replace the status quo.

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AN ANALYSIS COMPARING COMMANDER SUBMARINE FORCE U.S. PACIFIC FLEET (CSP) CURRENT INVENTORY MANAGEMENT TOOL VERSUS PACFLT REGIONAL INVENTORY STOCKING MODEL (PRISM), A PROPOSED DEMAND-BASED MANAGEMENT TOOL

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June 2003

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AN ANALYSIS COMPARING COMMANDER SUBMARINE FORCE U.S. PACIFIC FLEET (CSP) CURRENT INVENTORY MANAGEMENT TOOL VERSUS PACFLT REGIONAL INVENTORY STOCKING MODEL (PRISM), A PROPOSED DEMAND-BASED MANAGEMENT TOOL

ABSTRACT

This following project describes and assesses the current inventory stocking tool used by Commander U.S. Submarine Force Pacific Fleet (**CSP**), Mission Essential Spare Support (**MESS**), to manage its SSN stocking levels during a deployment work-up period. We also introduce a proposed demand based inventory management tool, Pacific Regional Inventory Stocking Model (**PRISM**), and compare it with the tools currently being used within CSP.

This analysis will then evaluate the effectiveness of each system as a management tool using data from CSP's SSN-688 Fast-Attack Submarines. The decision criteria estimated are operational readiness and associated inventory costs. Statistical simulation modeling will be employed to compare these evaluated criteria as determine by MESS and PRISM. This analysis provides evidence that with the inclusion of repair part demand data, cost savings will be realized for a specified inventory service level. Recommendations will be provided, based on the results of the comparison, as to the feasibility of implementing PRISM, maintaining MESS, or developing a new submarine stocking system to replace the status quo.

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EXECUTIVE SUMMARY

The following executive summary is provided in the form of a Microsoft® Power Point presentation, and acts as the centerpiece to this professional report. The format of this presentation is one slide per page with its accompanying notes section. Within each notes section is an abstract that provides an overview for the slide, the associated briefing script for each slide, and presenter notes that provide additional explanatory language or specific references.

Slide 1


PRISM
PACFLT Regional Inventory Stocking Model
Kurt Chivers
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1

Slide 2

Abstract: Agenda for presentation

Slide 3

Abstract: Project objectives slide

Briefing Script:

These objectives are complementary. A new method might achieve more effective supply support with the same inventory investment.

Slide 4

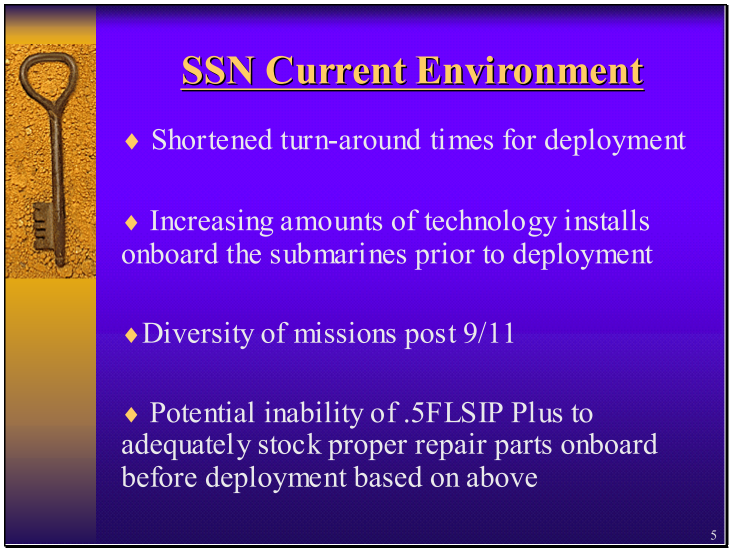
Abstract: The Typical Past Operating Environment

Briefing Script:

The operational tempo (OPTEMPO) of an SSN traditionally consists of one a six-month deployment every 24 months. In some cases the six month deployment is split into two three month theater deployments. The SSN will undergo an extended maintenance period call Submarine Refit Availability (SRA) during which major systems are repaired, replaced or updated. The 18 month turn-around period between deployments consists of one week to several months of operations composed of exercises, contingency operations, training and diplomatic missions. Approximately six months to a year before an SSN extended deployment, the ship will commence a work up, otherwise known as an extended training period, in which the crew and ship prepares and qualifies for the upcoming operations.

*Note: See Chapter I, section B, paragraph 1.

Slide 5



Abstract: The SSN Current Operating Environment

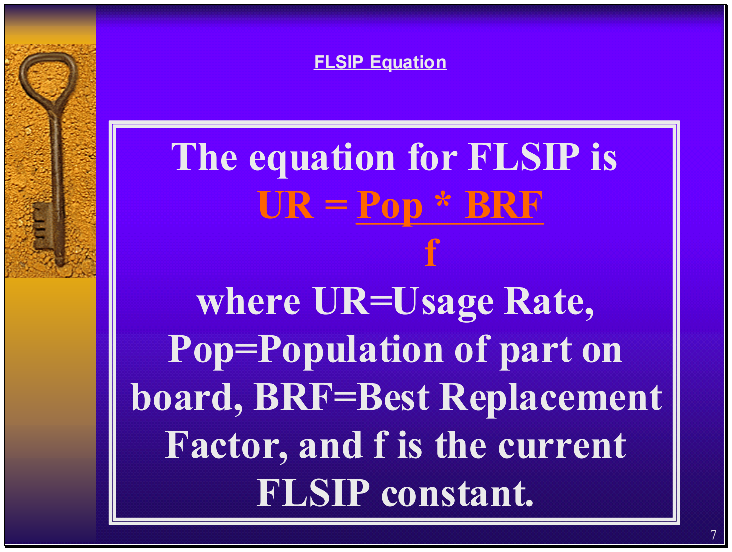
Briefing Script:

Inter-deployment turnaround times have shortened (due to 9/11, Afghan war, and Iraqi war) from 18 months to as low as every 12 months. Based upon the increased operational tempo, new systems are being installed at an increasing rate without the ability of the ship to adequately test for its own usage rate. Due to the above, the .5FLSIP Plus stocking model relies on the engineers BRF (Best Replacement factor) as an allowance.

Slide 6

Abstract: Evolution of FLSIP modeling

Slide 7



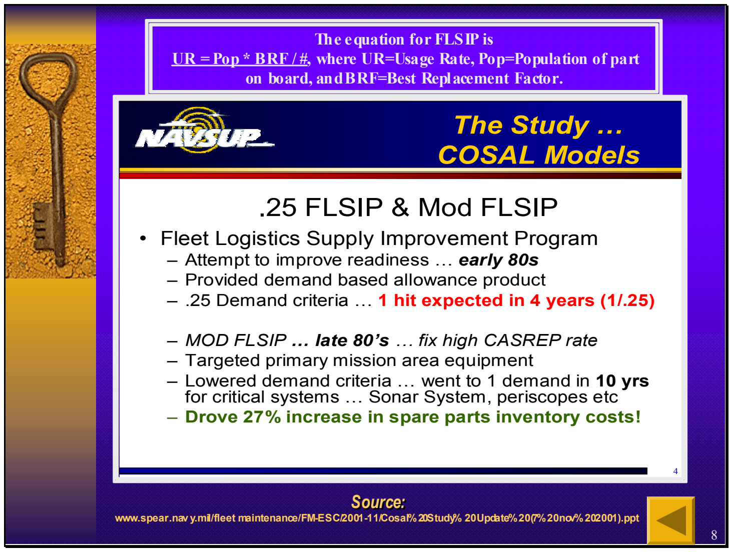
Abstract : This is the standard FLSIP equation for outfitting spares.

Briefing Script:

Explain equation and components.

*Note: See Chapter I, section C, paragraph 1.

Slide 8

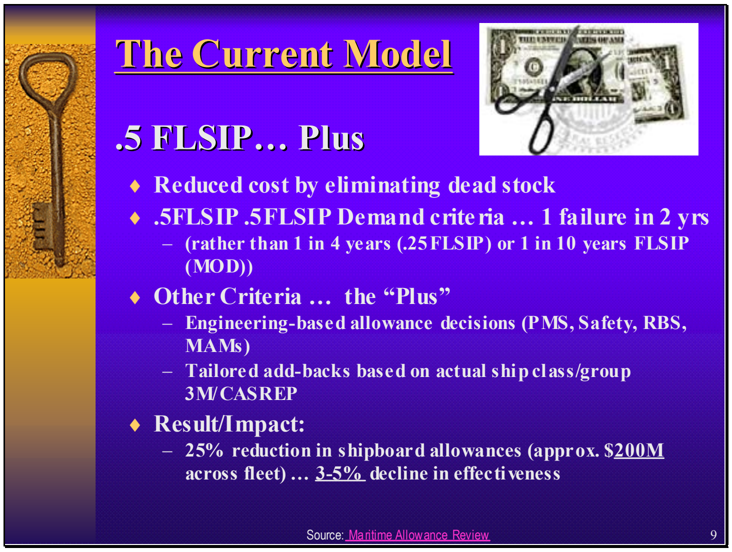


Abstract: FLSIP equation and evolution of the FLSIP program.

Briefing Script:

FLSIP was created during the early 1980's and was initially called .25FLSIP. It focused primarily on increasing readiness of the fleet. The predicted repair component usage rate threshold for .25FLSIP was set at one failure in four years to achieve the required stocking level. This was a best guess stocking level upon implementation of the FLSIP system. In the late 1980s, there was a push to decrease the CASREP (Casualty Report) rate within the surface and submarine force, especially in the area of primary mission equipment. As a result, the FLSIP model was to incorporate these changes and renamed MOD FLSIP, which lowered the demand criteria from one failure in four years to one failure in ten years for critical systems (sonar systems, periscopes, etc…). The result of MOD FLSIP was a dramatic increase in the number of repair parts held onboard ship, with a respective spike in increased repair parts spending.

Slide 9



Abstract: Explaining .5FLSIP and the Current Model now used in the fleet, .5FLSIP "Plus".

Briefing Script:

The .5FLSIP system replaced the MOD FLSIP system. The predicted usage rate threshold of .5FLSIP was set at one failure in two years to achieve prescribed stocking levels, thereby dramatically decreasing the number of spares held onboard submarines as compared to the MOD system.

With continual improvement in stocking algorithms, FLSIP evolved, yet again, into an even more streamlined, cost-effective stocking model called .5FLSIP *Plus*. Today's standard, .5FLSIP Plus, is a simple algorithm that utilizes the entire submarine communities' demand for repair components to predict future usage rates. It stocks quantities based on high and low limits. Any allowance candidate whose usage rate (UR) failed the .5FLSIP threshold criteria (one failure in two years) was deleted from the initial stocking then compared to a newly created demand-based data file.

*Note: See Chapter I, section C, paragraph 1a.

Slide 10

Abstract: Lead-in slide to MESS

Slide 11

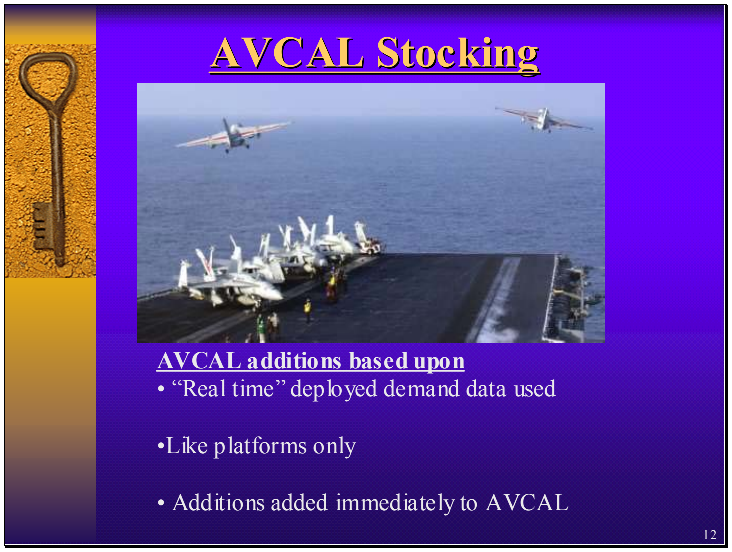
Abstract: Description of Mission Essential Spares Support (MESS).

Briefing Script:

Circa 1999, the status quo for PACFLT submarine supply management was the .5FLSIP program with an embedded node called the Mission Essential Spares Support (MESS). Together, this program analyzed eight critical submarine systems: fire control, sonar, periscopes, reactor, torpedo tubes, ballast control systems, electronic surveillance, and radio systems. These systems were identified by an Allowance Parts List (APL), and the purpose of running the MESS was to ensure a given submarine would have 100% parts support onboard prior to deployment. The MESS system program was run and analyzed only once prior to deployment (to verify stocking levels at 100%) at the D–120 date.

*Note: See Chapter I, section C, paragraph 1b.

Slide 12



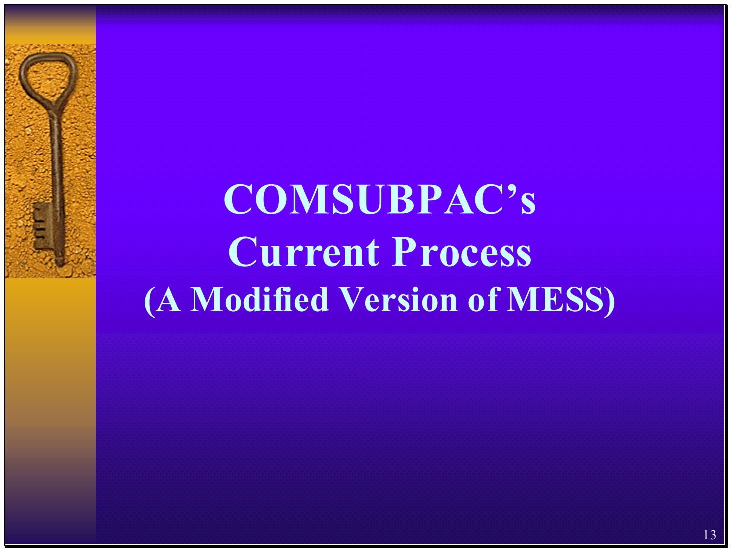
Abstract: Description of AVCAL (Aviation Coordinated Shipboard Allowance List).

Briefing Script:

Based on the FLSIP demand model, the aviation supply community uses an inventory control system called AVCAL (Aviation Coordinated Shipboard Allowance List) to manage stocking levels. This system compares theoretical demand data versus actual demand data of like platforms (e.g. LHD versus LHD, CVN versus CVN) to stock additional aviation repair components. In comparison, where COSALs .5FLSIP Plus model uses an algorithm to determine a change in a submarine's inventory level, the AVCAL model incorporates consumer level requirements that are in agreement with the approved maintenance plan. The deciding factor for a change in the quantity of repair components comes from the combination of an aviation repair component usage database and interaction with the supply manager. In reviewing AVCAL, the Navy's demand based model computes spare parts requirements one component at a time without regard to aircraft readiness or inventory cost. In other words, AVCAL's changes are decided primarily upon ***raw demand data*** submitted by the various squadrons.

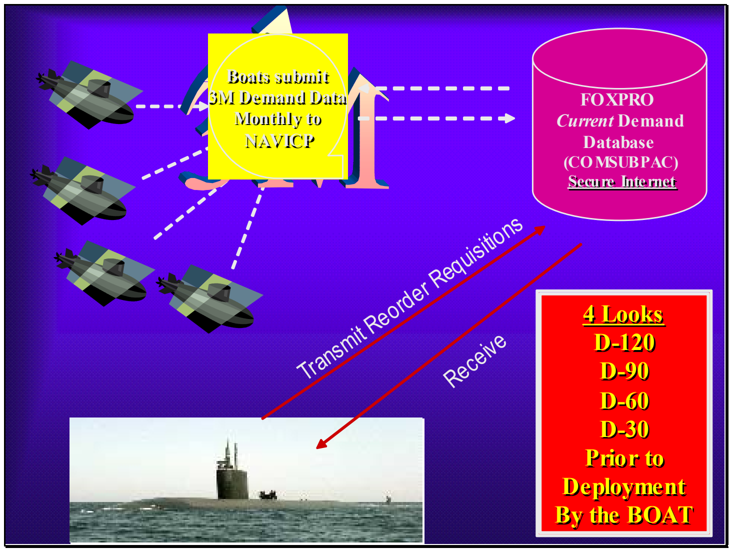
*Note: See Chapter I, section C, paragraph 2.

Slide 13



Abstract: Lead-in slide to CSP's current inventory process

Slide 14



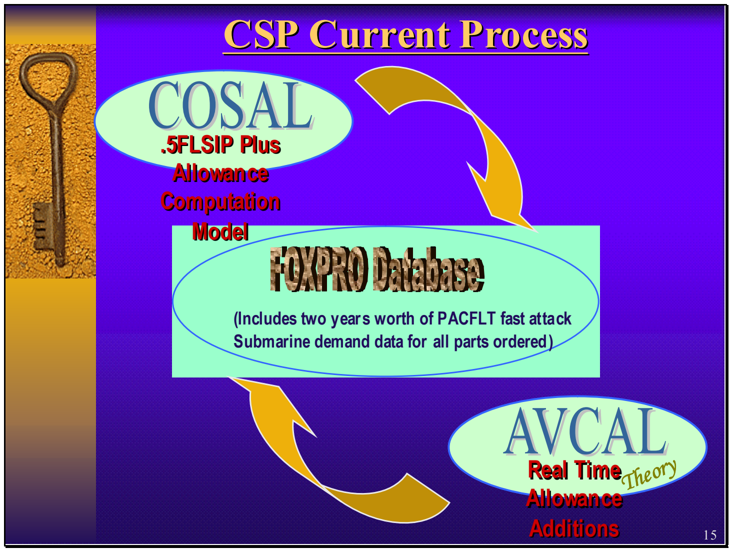
Abstract: COMSUBPAC's current requisition process utilizing FOXPRO database.

Briefing Script:

As a submarine prepares for deployment four months prior at D-120, the submarine supply officer runs his outstanding requisition listing. This is a listing of all repair components required by .5FLSIP Plus that are below High Limit and are being reordered. This listing is submitted to CSP from the submarine and run directly into the COMSUBPAC FOXPRO database. This database houses a full two years worth of demand of repair parts from *like* platforms. i.e.: 688 Los Angeles class fast attack submarines from the pacific fleet. This data is drawn down from the Navy's 3M database system which collects monthly demand data from all submarines. The FOXPRO database then compares the submarines reorder listing against the demand of all submarines in the Pacific Fleet.

*Note: See Chapter I, section C, paragraph 3.

Slide 15



Abstract: This is the CSP Current Process continued. This is a Modified Version of MESS that CSP uses.

Briefing Script:

In 1999, COMSUBPAC terminated the MESS node, desiring a different, more functional program to replace it. The follow on program would be capable of analyzing all systems and parts onboard a submarine versus only the selected eight (MESS). The emergent program was a merger of two inventory control systems, AVCAL stocking theory and the current .5FLSIP Plus. This merger would take AVCALs real time demand data theory and compare it to the .5FLSIP Plus stocking model data, depositing the resultant submarine usage rate into a FOXPRO database management system.

*Note: Note: See Chapter I, section C, paragraph 3.

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FOXPRO demand data from PACFLT 688's .5 FLSIP Plus

CSPDMD	CSPQTY	EFD	ALW	OHQTY
95	148	HYDRAULIC CONTROL-FWD	1	0
82	6322	Gasket 2 inch hyd.	61	0
75	81	GAS GENERATION-OXYGEN PLA	1	0
75	81	GAS GENERATION-OXYGEN PLA	1	0
72	743	FRESH WATER SYSTEM-AUXILI	4	0
68	644	DISTILLING PLANT-MAIN	8	0
67	95	WEAPON SYSTEM-MK67 LAUNCH	2	0
64	12581	SANITATION-TRASH COMPACTE	3	0
37	89	FIRE FIGHTING-HOSE	0	0
36	120	CONDENSING SYSTEM-MAIN CO	3	0
34	55	AN/WIC-2( ) INTERCOMMUNIC	1	0
33		IC-CIRCUIT KEH	1	0
33	39	IC-CIRCUIT KEH	1	0
33	67	IC-CIRCUIT MC INTEGRATED	1	0
28	31	TRIM X DRAIN SYSTEM-DRAIN	1	0
26	32	CO2 REMOVAL SYSTEM	0	0
18	26	FIRE FIGHTING-HOSE	5	0
13	16	FRESH WATER SYSTEM-AUXILI	1	0
12	29	AM-2210( )/WTC AUDIO FREQ	1	0
10	10	NANCY	1	0
10	18	IC-CIRCUIT MC INTEGRATED	3	0

Abstract: This is the output from the FOXPRO database in EXCEL format.

Briefing Script:

The report cutoff is taken at those parts that have a CSPDMD of 10 or greater. The report is sorted by CSPDMD, high to low, and then again by the ships OHQTY, low to high. The total number of parts that have a CSPDMD of 10 or greater and an ALW of zero are considered high priority (HI-PRI) requisitions. The Allowance (ALW) numbers are based upon the .5FLSIP model generated by NAVICP. These requisitions will be upgraded to the highest priority factor allowable by the supply system. The submarine supply officer, his immediate superior in command (ISIC), and the Naval Inventory Control Point (NAVICP) will ensure all identified HI-PRI items are onboard prior to deployment day (D-0). This enhancement program will be run four times prior to deployment, starting at D-120 (120 days before deployment), and subsequently at D-90, D-60, and D-30. At D-30, the submarine stops issuing repair components from its own onboard stock. The remaining components considered HI-PRI will be brought onboard from free issue stocking programs or transferred from other non-deploying submarines.

*Note: See Chapter I, section C, paragraph 3.

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USS CHICAGO MESS REPORT (CSP Demand =/> 10)

Line	Category	D-120	D-90	D-60	D-30	D+1
1	Number of requisitions (=/>10 Demands)	42	54	134	64	10
2	Number of invalid requisitions	2	2	4	4	0
3	Net requisitions (Line 1 - Line 2) (=/>10 Demands)	40	52	130	60	10
4	Number of requisitions received at 452K (LCAV)	27	36	113	50	2
5	Number of requisitions received by boat (LCAV)	0	0	0	0	0
6	Number of requisitions filled from free issue	0	0	0	0	7
7	Requisitions received or filled (Line 4 + 5 + 6) (=/>10 Demands)	27	36	113	50	9
8	**Items remaining (Line 3 - Line 7) (=/>10 Demands)**	**13**	**16**	**17**	**10**	**1**
9	**Other Data**	D-120	D-90	D-60	D-30	D+1
10	Number of requisitions priority upgraded (AMA)	8	2	12	4	0
11	NSNs referred to CSP for research (See sheet 2)	0	1	0	0	0
12	Total number Requisitions added and deleted since D-120	N/A	44A/32D	165A/73D	188A/166D	188A/166D
13	Requisitions added and deleted since D-90	N/A	N/A	121A/41D	144A/134D	144A/134D
14	Requisitions added and deleted since D-60	N/A	N/A	N/A	23A/93D	23A/93D
15	Cumulative total Requisitions since D-120 (=/>10 Demands)	42	96	230	294	294

Abstract: An example of a FOXPRO database summary sheet from CSP.

Briefing Script:

This is a summary sheet that is provided to the ISIC and to the Submarine Supply Officer after a report has been run through the FOXPRO database. It is a breakdown of the number of requisitions that are currently outstanding and required to be onboard prior to deployment. Note that this is only an ***expediting tool***. There are no changes being made to the .5FLSIP allowances of the individual submarine.

Slide 18

Abstract: Limitations of CSP's current process and management tools.

Briefing Script:

Expediting Tool only: Affects only high demand items with CSPDMD of 10 or greater. Only looks at a submarines OHQTY of zero. Does not take into account the cost of inventory, potential adds or deletes. Extreme amounts of data available, however, data mining issues are non-existent.

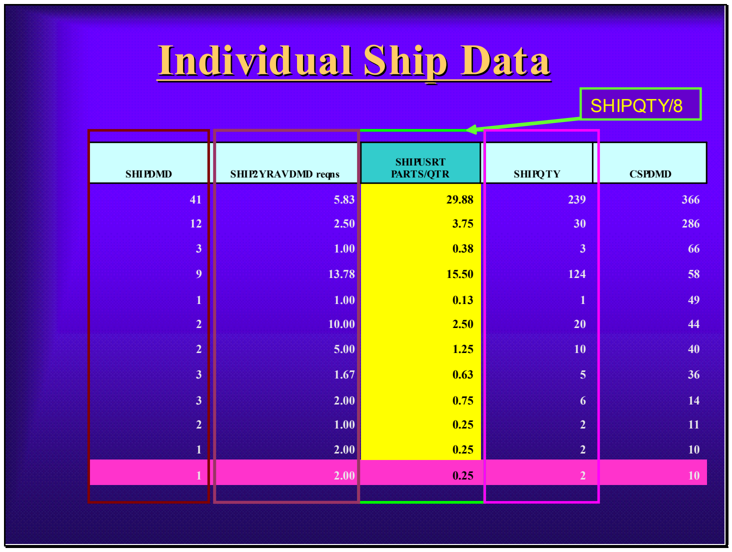
Slide 19

Abstract: Our project lead-in slide

Slide 20

Abstract: Our proposed model as evolved from .5FLSIP Plus

Slide 21



SHIPDMD	SHIP2YRAVDMD reqns	SHIPUSRT PARTS/QTR	SHIPQTY	CSPDMD
41	5.83	29.88	239	366
12	2.50	3.75	30	286
3	1.00	0.38	3	66
9	13.78	15.50	124	58
1	1.00	0.13	1	49
2	10.00	2.50	20	44
2	5.00	1.25	10	40
3	1.67	0.63	5	36
3	2.00	0.75	6	14
2	1.00	0.25	2	11
1	2.00	0.25	2	10
1	2.00	0.25	2	10

Abstract: PRISM ship part information.

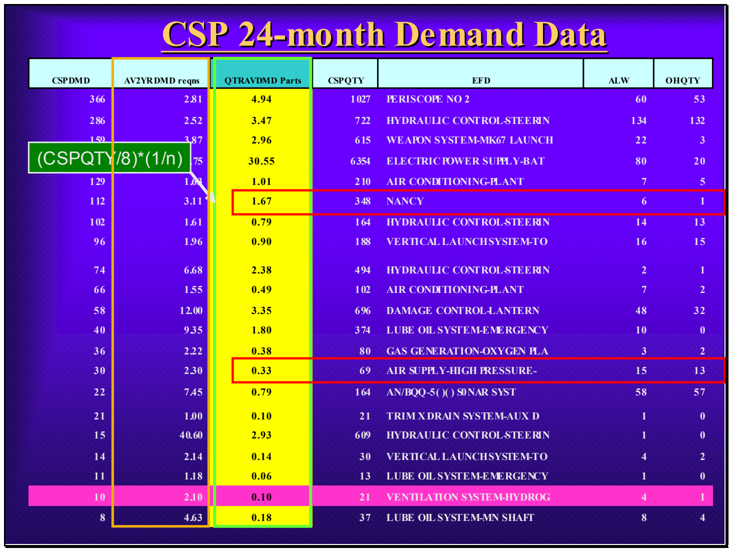
Briefing Script:

Basic information about usage rates for individual parts specific to individual submarines. This will vary between submarines and is dependent on variables such as ship age, material history, and operational profile. **(ANIMATION)** SHIPDMD represents the number of requisitions for a specific part made by the ship over a 24-month period, and **(ANIMATION)** SHIPQTY represents the number of parts requested over the same period. **(ANIMATION)** SHIP2YRAVDMD shows the number of parts demanded by the ship per requisition on average, and **(ANIMATION)** SHIPUSRT PARTS/QTR are derived from the previous values.

Recall, a baseline assumption is evaluating stock levels over a 90-deployment period. **(ANIMATION)** This assumption yields 8 quarter periods in a 24 month period. Using this number the average usage rate per part per 90-day period can be determined.

*Note: See Chapter II, PRISM discussion.

Slide 22



CSPDMD	AV2YRDMD reqns	QTRAVDMD Parts	CSPQTY	EFD	ALW	OHQTY
366	2.81	4.94	1027	PERISCOPE NO 2	60	53
286	2.52	3.47	722	HYDRAULIC CONTROL-STEERIN	134	132
159	3.87	2.96	615	WEAPON SYSTEM-MK67 LAUNCH	22	3
[illegible]	[illegible]	30.55	6354	ELECTRIC POWER SUPPLY-BAT	80	20
129	[illegible]	1.01	210	AIR CONDITIONING-PLANT	7	5
112	3.11	1.67	348	NANCY	6	1
102	1.61	0.79	164	HYDRAULIC CONTROL-STEERIN	14	13
96	1.96	0.90	188	VERTICAL LAUNCH SYSTEM-TO	16	15
74	6.68	2.38	494	HYDRAULIC CONTROL-STEERIN	2	1
66	1.55	0.49	102	AIR CONDITIONING-PLANT	7	2
58	12.00	3.35	696	DAMAGE CONTROL-LANTERN	48	32
40	9.35	1.80	374	LUBE OIL SYSTEM-EMERGENCY	10	0
36	2.22	0.38	80	GAS GENERATION-OXYGEN PLA	3	2
30	2.30	0.33	69	AIR SUPPLY-HIGH PRESSURE-	15	13
22	7.45	0.79	164	AN/BQQ-5( )( ) SONAR SYST	58	57
21	1.00	0.10	21	TRIM X DRAIN SYSTEM-AUX D	1	0
15	40.60	2.93	609	HYDRAULIC CONTROL-STEERIN	1	0
14	2.14	0.14	30	VERTICAL LAUNCH SYSTEM-TO	4	2
11	1.18	0.06	13	LUBE OIL SYSTEM-EMERGENCY	1	0
10	2.10	0.10	21	VENTILATION SYSTEM-HYDROG	4	1
8	4.63	0.18	37	LUBE OIL SYSTEM-MN SHAFT	8	4

Abstract: Slide shows the creation of CSP PRISM data and comparisons to the FLSIP allowance and ship stocking levels.

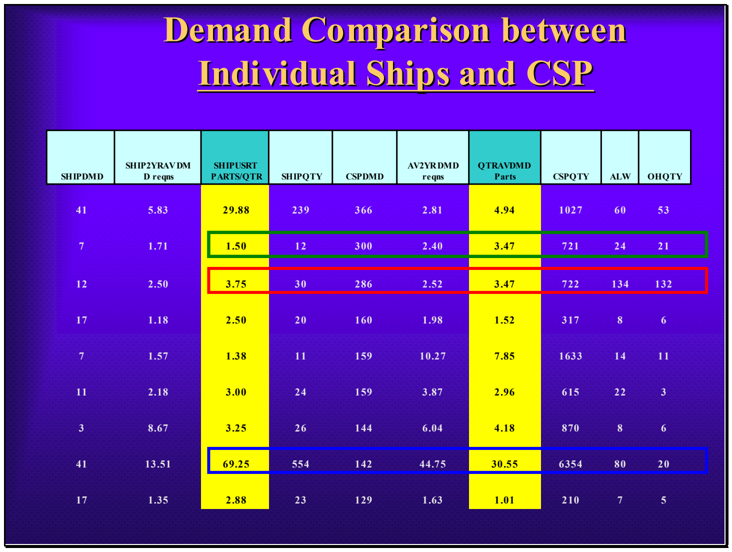
Briefing Script:

Derived from the MESS report CSP 24-month aggregate data is filtered, augmented, and calculated to create 90-day demand data. CSPDMD and CSPQTY values are carried over from the original MESS report as are ALW and OHQTY. Two new columns are introduced in the PRISM report. First, **(ANIMATION)** AV2YRDMD represents the average parts per requisition over two years. Second, **(ANIMATION)** QTRAVDMD represents the average number of parts demanded per 90-days (the assumed evaluation period) per ship (n, assumed to be 26), and are baseline demand values.

Once the part demand data has been calculated, initial snapshot comparisons are available to the inventory manager; **(ANIMATION)** QTRAVDMD vs. ALW, and QTRAVDMD vs. OHQTY.

*Note: See Chapter II PRISM discussion.

Slide 23



SHIPDMD	SHIP2YRAVDMD reqns	SHIPUSRT PARTS/QTR	SHIPQTY	CSPDMD	AV2YRDMD reqns	QTRAVDMD Parts	CSPQTY	ALW	OHQTY
41	5.83	29.88	239	366	2.81	4.94	1027	60	53
7	1.71	1.50	12	300	2.40	3.47	721	24	21
12	2.50	3.75	30	286	2.52	3.47	722	134	132
17	1.18	2.50	20	160	1.98	1.52	317	8	6
7	1.57	1.38	11	159	10.27	7.85	1633	14	11
11	2.18	3.00	24	159	3.87	2.96	615	22	3
3	8.67	3.25	26	144	6.04	4.18	870	8	6
41	13.51	69.25	554	142	44.75	30.55	6354	80	20
17	1.35	2.88	23	129	1.63	1.01	210	7	5

Abstract: Slide shows how ship demand compares to CSP average demand, ALW and OHQTY.

Briefing Script:

Combining both the ship and CSP PRISM report elements provides the inventory manager with the first management tool product. This PRISM tool is a snapshot comparison between ship demand (SHIPUSRT), CSP demand (QTRAVDMD), FLSIP allowance (ALW), and stock level (OHQTY).

First, **(ANIMATION)** comparing ship demand to CSP demand can show a match; Second, **(ANIMATION)** here mismatches are noted between demand levels. In all cases it is seen the FLSIP allowance level does not match either demand level (CSP or Ship). This data and the subsequent comparisons set up the premise for model construction and simulations involved with determining optimal stocking levels.

Note: Chapter II, PRISM discussion.

Slide 24

Allowance in Excess of CSP Demand

BAL	ALW<100%(QTRAVDMD)	Add'l Costs	ALW<.75(QTRAVDMD)	Add'l Costs	ALW<.5(QTRAVDMD)	Add'l Costs	ALW<.25(QTRAVDMD)	Add'l Costs
OK	no	N/A	no	N/A	no	N/A	no	N/A
OK	no	N/A	no	N/A	no	N/A	no	N/A
OK	no	N/A	no	N/A	no	N/A	no	N/A
OK	no	N/A	no	N/A	no	N/A	no	N/A
OK	no	N/A	no	N/A	no	N/A	no	N/A
WHY?	YES!	12.36	YES!	8.31	YES!	4.26	YES!	0.20
OK	no	N/A	no	N/A	no	N/A	no	N/A
WHY?	no	N/A	no	N/A	no	N/A	no	N/A
OK	YES!	35.38	YES!	23.64	YES!	11.90	YES!	0.15
OK	no	N/A	no	N/A	no	N/A	no	N/A
OK	no	N/A	no	N/A	no	N/A	no	N/A
OK	no	N/A	no	N/A	no	N/A	no	N/A
OK	no	N/A	no	N/A	no	N/A	no	N/A
OK	no	N/A	no	N/A	no	N/A	no	N/A
OK	YES!	1.80	no	N/A	no	N/A	no	N/A
OK	no	N/A	no	N/A	no	N/A	no	N/A
OK	no	N/A	no	N/A	no	N/A	no	N/A
OK	no	N/A	no	N/A	no	N/A	no	N/A
2	3	$ 49.55	2	$ 31.95	2	$ 16.15	2	$ 0.36

Abstract: PRISM Section 2, FLSIP allowance in excess of CSP demand (QTRAVDMD)

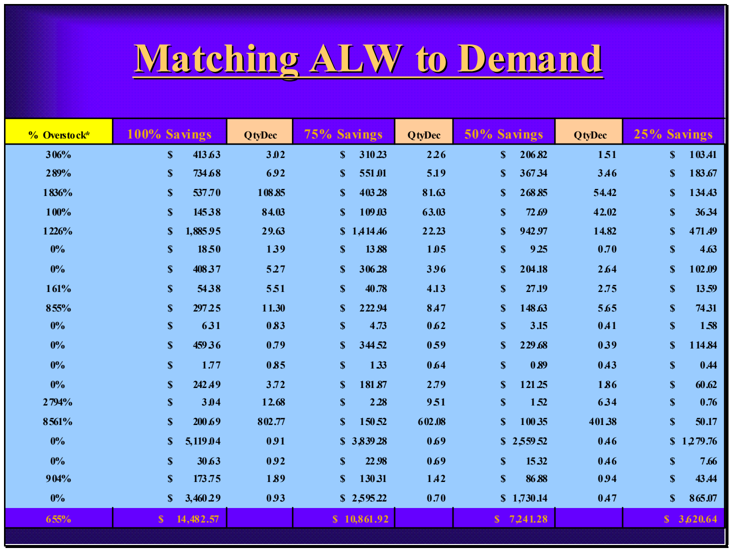
Briefing Script:

Section 2 of the PRISM report identifies if OHQTY is less than CSP Demand (seen in BAL), identifies if the FLSIP allowance is below a specific quartile level of CSP demand (QTRAVDMD), and identifies the individual part and aggregate costs of increasing part allowances to match the CSP demand levels.

The advantage of evaluating ALW and costs against quartile levels is it provides information to the inventory manager that helps them manage risk while making stocking decisions.

*Note: Chapter II, PRISM section 2 discussion.

Slide 25



% Overstock*	100% Savings	QtyDec	75% Savings	QtyDec	50% Savings	QtyDec	25% Savings
306%	$ 413.63	3.02	$ 310.23	2.26	$ 206.82	1.51	$ 103.41
289%	$ 734.68	6.92	$ 551.01	5.19	$ 367.34	3.46	$ 183.67
1836%	$ 537.70	108.85	$ 403.28	81.63	$ 268.85	54.42	$ 134.43
100%	$ 145.38	84.03	$ 109.03	63.03	$ 72.69	42.02	$ 36.34
1226%	$ 1,885.95	29.63	$ 1,414.46	22.23	$ 942.97	14.82	$ 471.49
0%	$ 18.50	1.39	$ 13.88	1.05	$ 9.25	0.70	$ 4.63
0%	$ 408.37	5.27	$ 306.28	3.96	$ 204.18	2.64	$ 102.09
161%	$ 54.38	5.51	$ 40.78	4.13	$ 27.19	2.75	$ 13.59
855%	$ 297.25	11.30	$ 222.94	8.47	$ 148.63	5.65	$ 74.31
0%	$ 6.31	0.83	$ 4.73	0.62	$ 3.15	0.41	$ 1.58
0%	$ 459.36	0.79	$ 344.52	0.59	$ 229.68	0.39	$ 114.84
0%	$ 1.77	0.85	$ 1.33	0.64	$ 0.89	0.43	$ 0.44
0%	$ 242.49	3.72	$ 181.87	2.79	$ 121.25	1.86	$ 60.62
2794%	$ 3.04	12.68	$ 2.28	9.51	$ 1.52	6.34	$ 0.76
8561%	$ 200.69	802.77	$ 150.52	602.08	$ 100.35	401.38	$ 50.17
0%	$ 5,119.04	0.91	$ 3,839.28	0.69	$ 2,559.52	0.46	$ 1,279.76
0%	$ 30.63	0.92	$ 22.98	0.69	$ 15.32	0.46	$ 7.66
904%	$ 173.75	1.89	$ 130.31	1.42	$ 86.88	0.94	$ 43.44
0%	$ 3,460.29	0.93	$ 2,595.22	0.70	$ 1,730.14	0.47	$ 865.07
655%	$ 14,482.57		$ 10,861.92		$ 7,241.28		$ 3,620.64

Abstract: This slide shows the level of inventory overstock (compared to CSP demand), and the cost savings and inventory adjustments required to match FLSIP allowance to CSP demand.

Briefing Script:

This slide depicts section three of the PRISM report. Section three consists of three parts. First, %Overstock compares current ship stock levels to CSP demand quantities. Second, savings are displayed that would result from adjusting the FLSIP allowance to match the specified CSP demand level. Third, the amount of inventory adjustment required to match ALW to CSP quarterly demand levels.

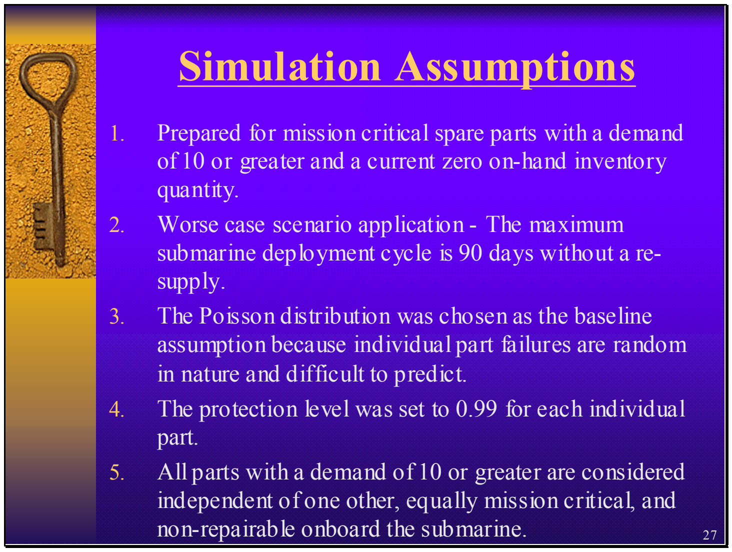
The value of this section lies in the dollar numbers evident at each requisition period that can be realized if ALW levels are matched to observed average demand levels. Additionally, when coupled with the levels provided by the following model, optimal stocking levels can be determined that will maximize operational readiness (based on the managers desired risk level) and cost savings.

*Note: Chapter II, PRISM section 3 discussion.

Slide 26

Abstract: Proposed Crystal Ball simulation model

Slide 27



Abstract: Assumptions for Crystal Ball simulation

Briefing Script:

The simulation was prepared for mission critical spare parts with a demand of 10 or greater and a current zero on-hand inventory quantity.

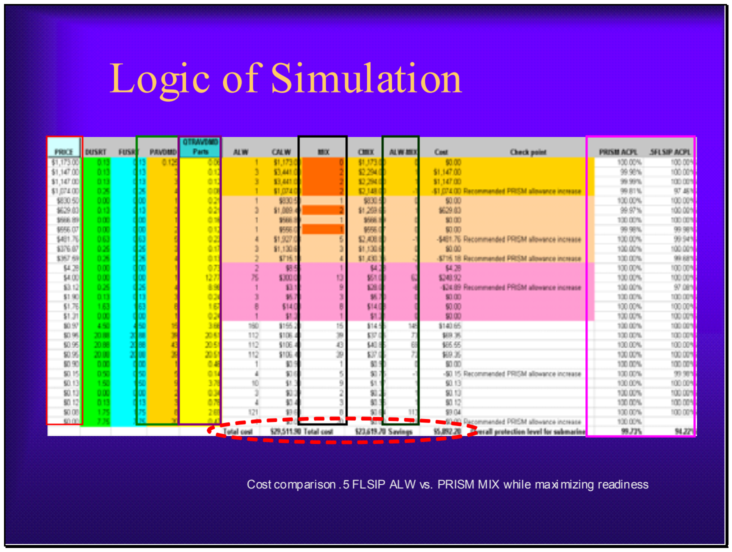
The maximum submarine deployment cycle is ninety days without a re-supply. A period of ninety days was chosen based upon historical information provided by CSP Supply Department and is chosen for the worse case scenario application.
Within the context of the Crystal Ball software, assumptions represent the probability distributions utilized in creating and analyzing simulations**.** Because individual part failures are random in nature and difficult to predict, the Poisson distribution was chosen as the baseline assumption. This distribution involves counting the number of times a random event occurs during a fixed time period; i.e., distance, area, etc. For the purpose of this analysis the mean used in the Poisson distribution equates to usage rate for a particular part over the evaluated period.

While running simulations to estimate the desired inventory level, the protection level was set to 0.99 for each individual part. With this level of certainty, a submarine will experience a stockout 1 out of every 100 cases.

All parts with a demand of 10 or greater are considered independent of one other, equally mission critical, and non-repairable onboard the submarine.
Mission critical spare parts are defined as those parts that, if failure should occur, would cause a submarine to come off-station in the event of an inventory stockout.

*Note: See Chapter III, section C, paragraphs 1-5.

Slide 28



Abstract: Simulation table

Briefing Script:

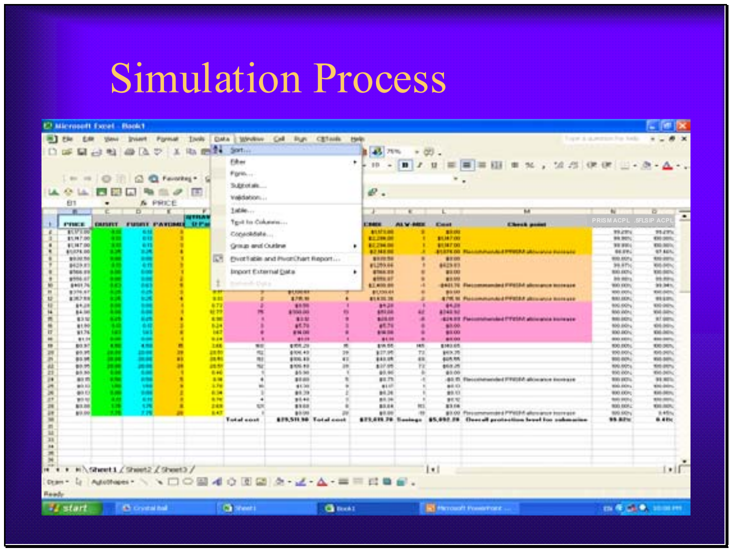
Generated by the Crystal Ball, predicted average demand for 90 days deployment (PAVDMD) needs to be compare with quarterly average demand (QAVDMD) and pick up a higher number. It allows to maintain the same level of readiness because we compare predicted average demand of a particular submarine vs. quarterly average demand among all submarine USS 688 class on PACFLT. The result of the comparison is displayed in the “MIX” column. This column represents PRISM allowance that is recommended to have on board of submarine for 90 days deployment.

In order to compare PRISM and .5FLSIP we compare two allowances, one is .5FLSIP (“ALW” column) and PRISM (“MIX” column). The difference is presented in the column “ALW-MIX”.

Costs were assigned to the results of comparisons and presented at the bottom of the table. Check point was designed to give information about recommendation to increase .5 FLSIP allowance in case if it is lower than PRISM allowance

*Note: See Chapter III for more information.

Slide 29

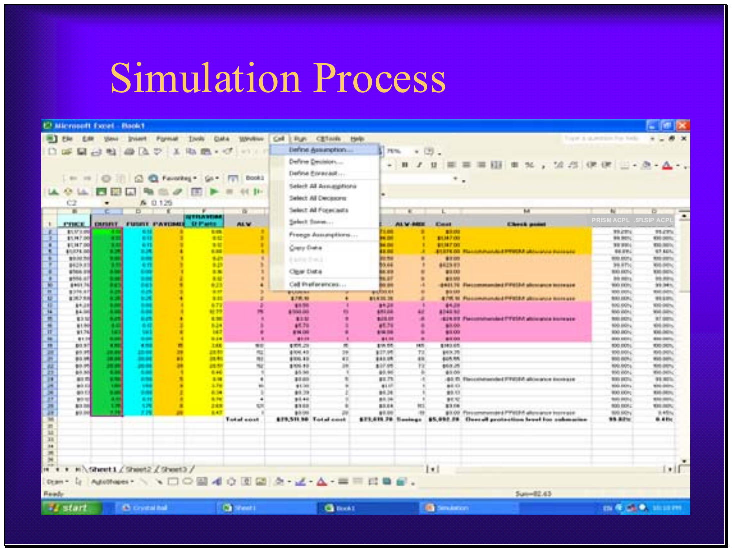


Abstract: Definition of the Usage Rate distribution

Briefing Script:

This slide shows a beginning of the simulation by defining the distribution of the given usage rate for a particular part. In order to define the distribution of the usage rate we are highlighting the column DUSRT, which represent defined usage rate and click on the "CELL" on the control panel. Then we choose "Define Assumption" from the pop-up menu options.

Slide 30



Abstract: Definition of the Usage Rate distribution

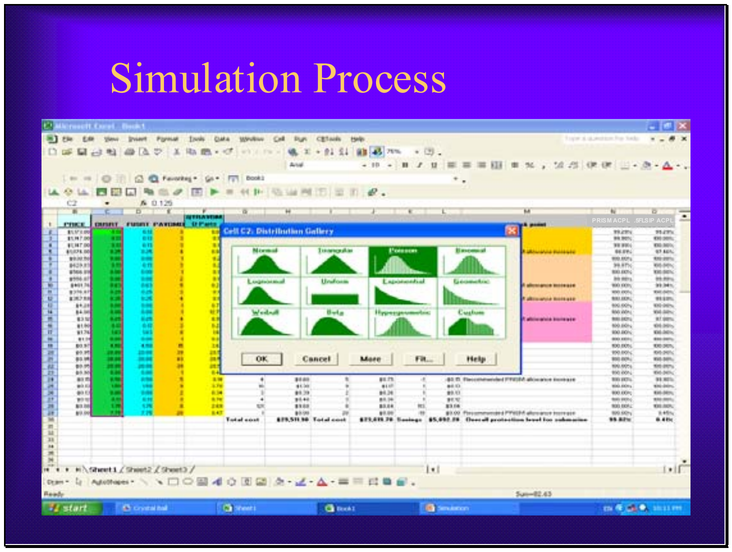
Briefing Script:

This slide shows a beginning of the simulation by defining the distribution of the given usage rate for a particular part. In order to define the distribution of the usage rate we are highlighting the column DUSRT, which represent defined usage rate and click on the "CELL" on the control panel.

Then we choose "Define Assumption" from the pop-up menu options.

*Note: See Chapter III, section E, paragraph 1.

Slide 31



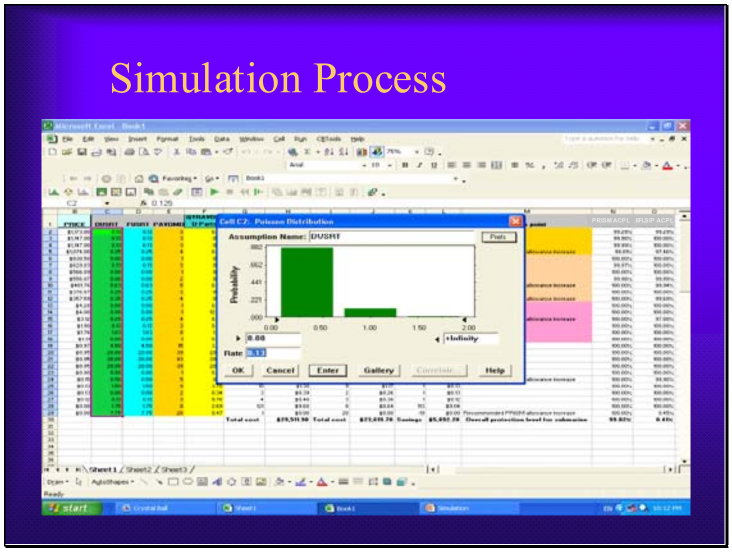
Abstract: Choosing a Poisson distribution for usage rate

Briefing Script:

This slide represents a gallery function of the Crystal Ball, which allows us to choose a distributing function for parts usage rate. We pick up Poisson distribution from the gallery

*Note: See Chapter III for more information

Slide 32

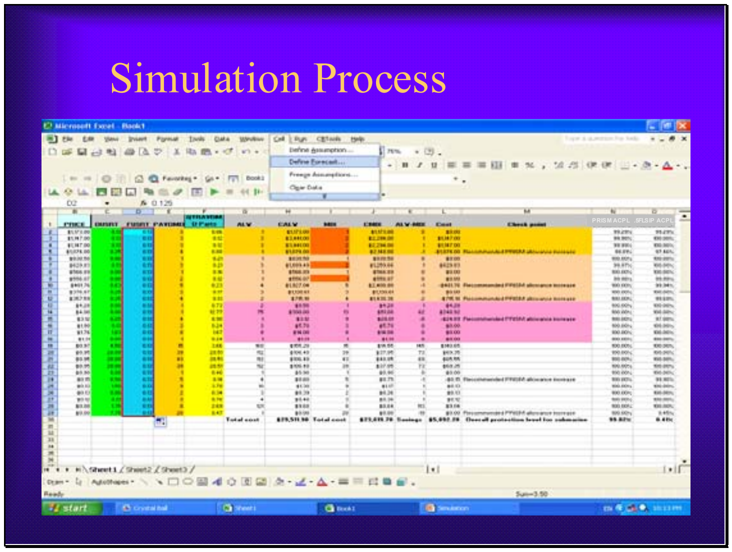


Abstract: Definition of the Poisson function

Briefing Script:

This slide shows a pop-up menu with options to define the mean (usage rate) for Poisson distribution. Crystal ball automatically defines the mean for the Poisson distribution based on the usage rate represented in the column "AT" of the Excel spreadsheet.

Slide 33

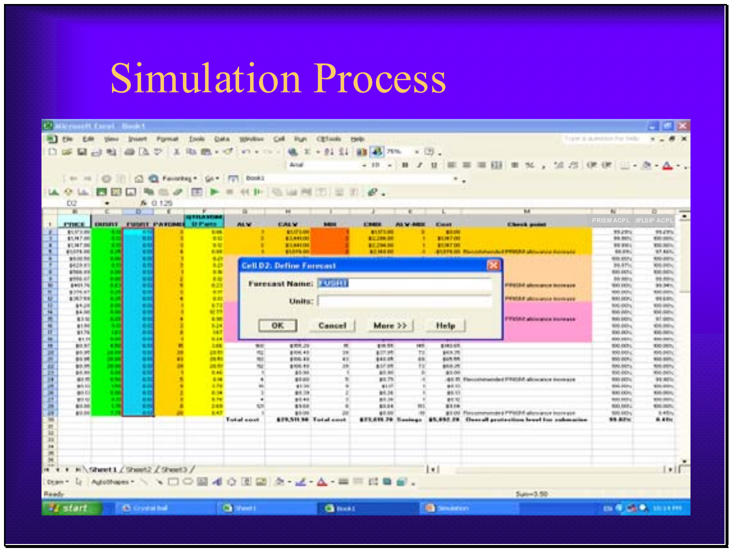


Abstract: Definition of the forecasted cell

Briefing Script:

This slide shows the process of defining the forecasted cell. In order to define the forecasted usage rate we are highlighting the column “FUSRT”, which represent forecasted usage rate and click on the “CELL” on the control panel. Then we choose “Define Forecast” from the pop-up menu options.

Slide 34

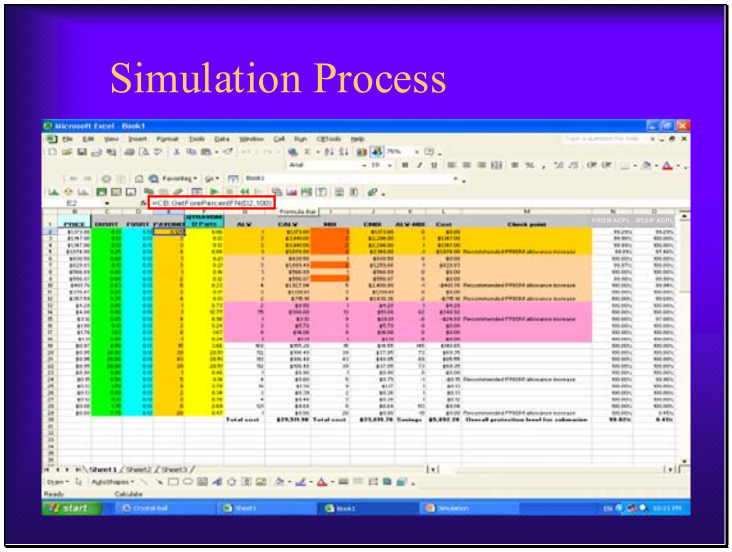


Abstract: Definition of the forecast name

Briefing Script:

This slide shows the definition of the name for our forecasted usage rate, which can be automatically picked by the Crystal Ball.

Slide 35



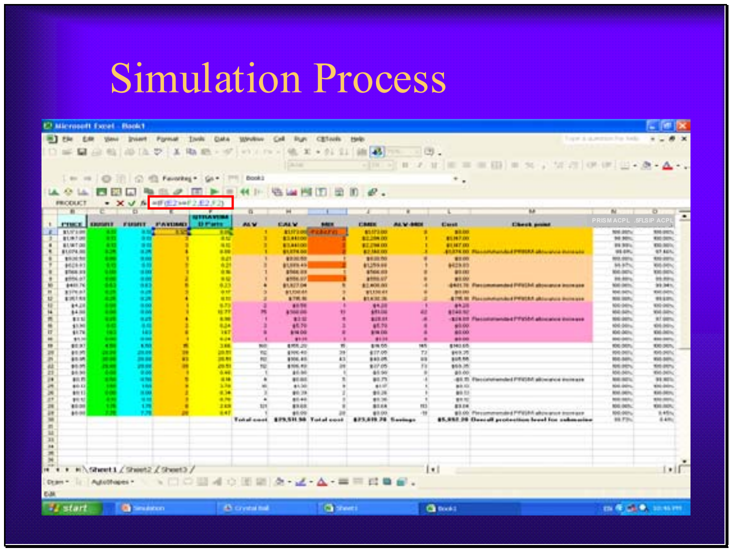
Abstract: Creating the simulation results column

Briefing Script:

This slide shows the formula in the formula bar that we have to put in the Excel spreadsheet to retrieve the result of the simulation from the Crystal Ball and place it into the spreadsheet.

*Note: See Chapter III for formula explanation.

Slide 36



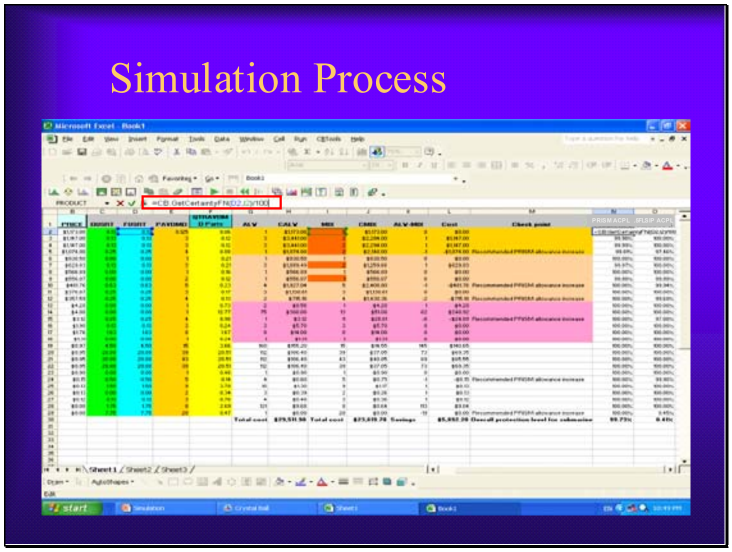
Abstract: Definition of the "MIX" column

Briefing Script:

This slide shows the format of the formula that was placed in the "MIX" column to determine the best mix between simulated average demand and given quarterly average demand.

*Note: See Chapter III for more information.

Slide 37

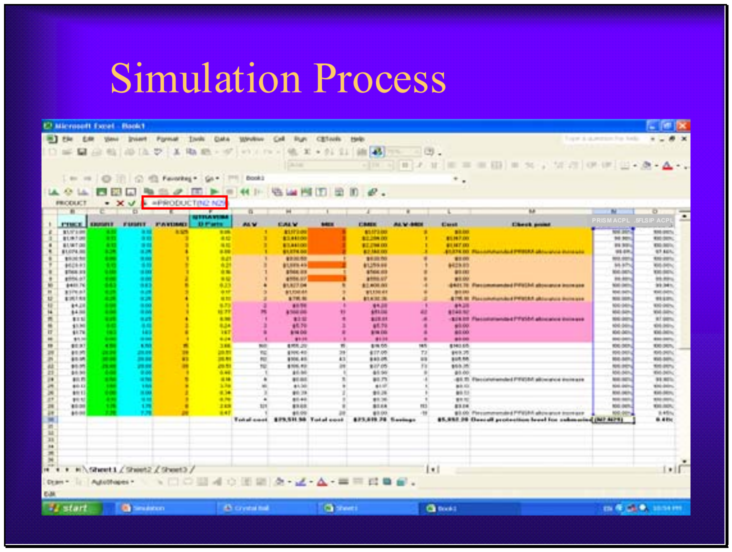


Abstract: PRISM Actual Protection Level

Briefing Script:

This is the actual protection level generated by the Crystal Ball using the Optimum mix quantity and the forecasted usage rate for each individual part.

Slide 38

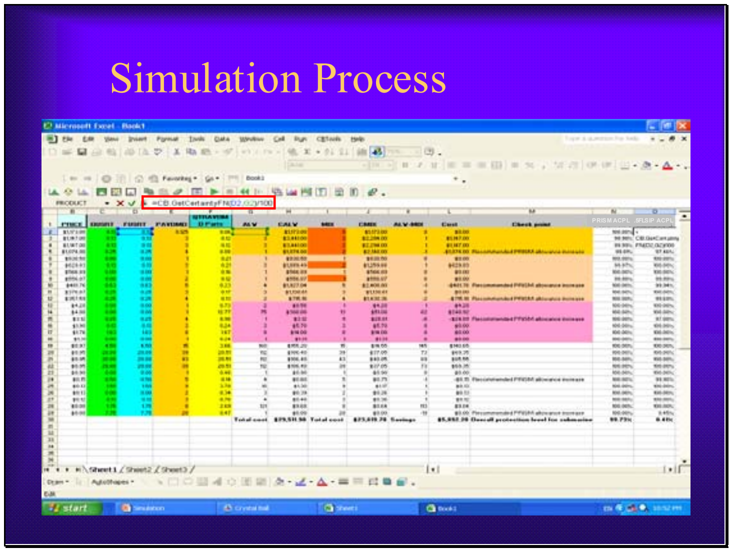


Abstract: Overall Submarine Protection Level

Briefing Script:

Overall submarine protection level can be found by multiplying all individual protection level percentages together.

Slide 39

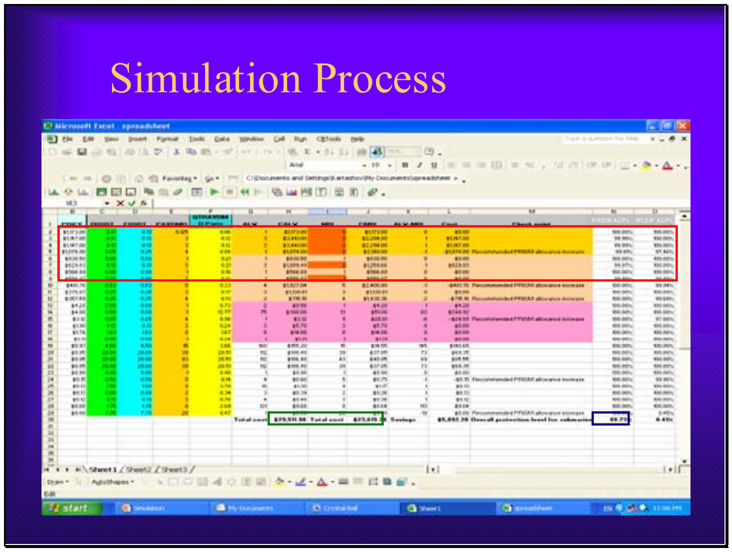


Abstract: .5FLSIP Actual Protection Level

Briefing Script:

This is the actual protection level generated by the Crystal Ball using the .5FLSIP allowance quantity and the forecasted usage rate for each individual part.

Slide 40

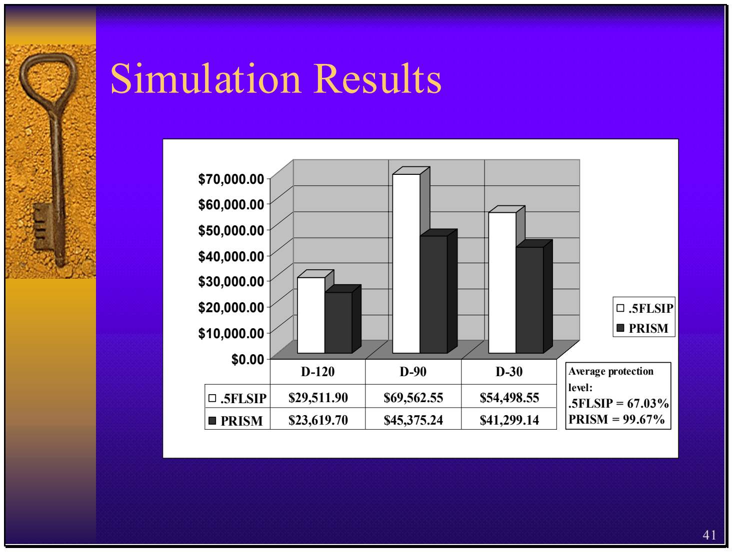


Abstract: Decision making process

Briefing Script:

As a basis for the budget constraint, the cost of the inventory under .5FLSIP was chosen, allowing us to alter the inventory mix in order to maintain a high readiness level. PRISM determines the optimum level of inventory based upon the duration of the deployment, usage rate, and protection level. It highlights those spare parts that are under-stocked, thereby allowing a possible increase in allowance for those particular parts.

Slide 41

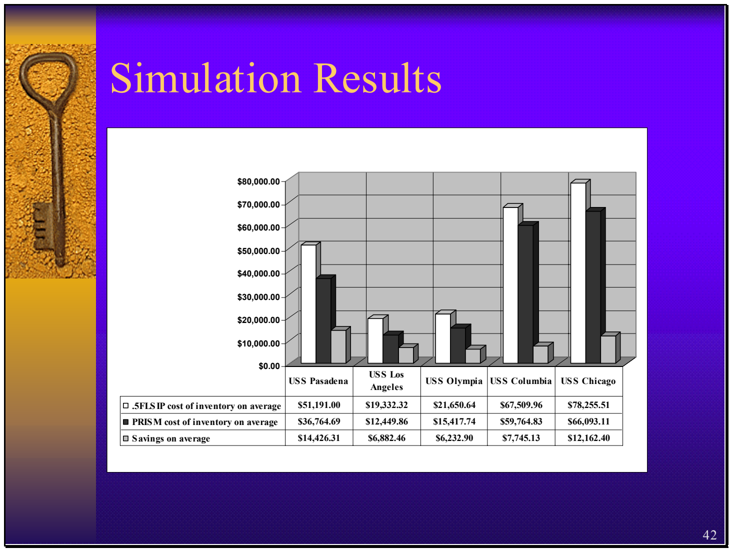


Abstract: Simulation results

Briefing Script:

The cost of inventory depends on the service (protection) level chosen by the Supply Officer. The service (protection) level variant depends upon many factors, such as budgetary constraints (cost of the items), operating costs (cost of re-supply, delivery cost), and opportunity cost (cost of a mission failure). As an example, we utilized the data from the USS Pasadena to illustrate the advantage of PRISM versus the .5FLSIP in increasing the overall readiness while reducing inventory costs.

Slide 42



	USS Pasadena	USS Los Angeles	USS Olympia	USS Columbia	USS Chicago
.5FLSIP cost of inventory on average	$51,191.00	$19,332.32	$21,650.64	$67,509.96	$78,255.51
PRISM cost of inventory on average	$36,764.69	$12,449.86	$15,417.74	$59,764.83	$66,093.11
Savings on average	$14,426.31	$6,882.46	$6,232.90	$7,745.13	$12,162.40

Abstract: Simulation results

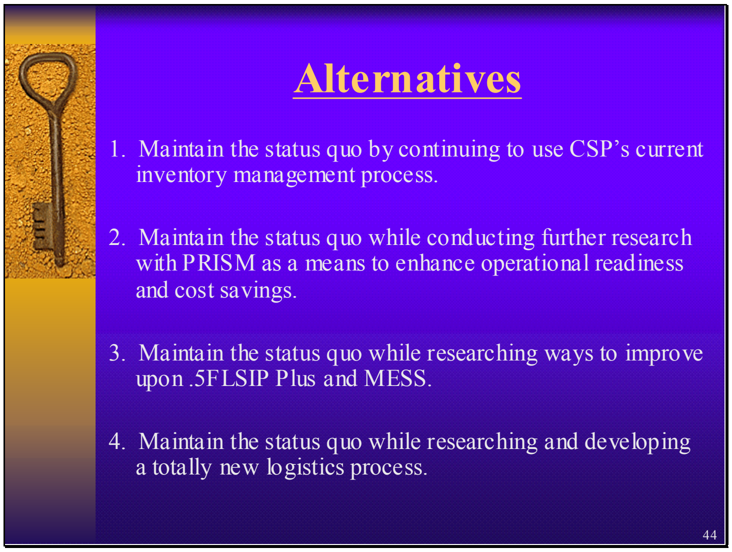
Briefing Script:

The results shown above is a comparison in inventory costs using both .5FLSIP and PRISM allowances. The information used to determine the average cost of inventory was provided by the CSP D-120/90/60/30 submarine data reports and separated between .5FLSIP and PRISM. As a basis for the budget constraint, the cost of the inventory under .5FLSIP was chosen, allowing us to alter the inventory mix in order to maintain a high readiness level. PRISM determines the optimum level of inventory based upon the duration of the deployment, usage rate, and service (protection) level.

*Note: See Chapter III

Slide 43

Slide 44



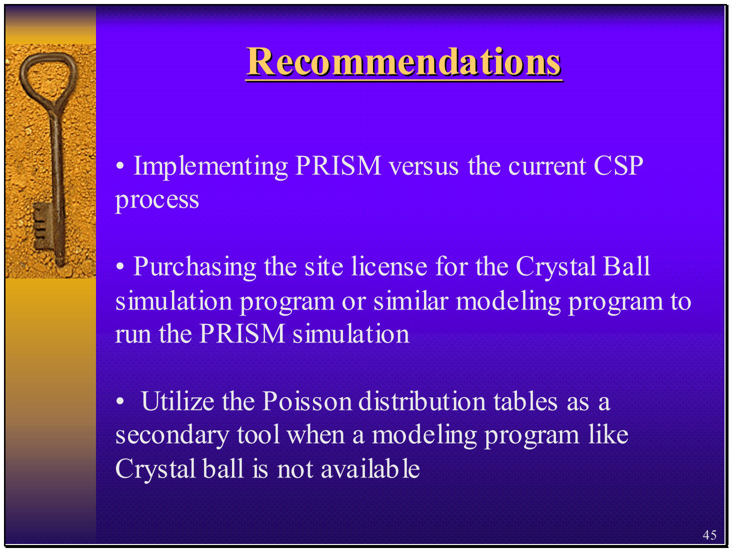
Abstract: Alternatives to using PRISM.

Briefing Script:

Proper inventory management can impact submarine operational readiness as significantly as proper training and personnel leadership. Introduction of new inventory management tools demands careful development and consideration prior to replacing current legacy systems. In light of the import associated with properly managing submarine inventories, alternatives are offered to implementing PRISM as a standalone product.

*Note: See Chapter IV, Section A, paragraphs 1-4.

Slide 45



Abstract: Recommendations

Briefing Script:

1. Based on the PRISM reports (excel spreadsheets) and simulation results in chapter three, we recommend implementing PRISM versus the current CSP process., for significant cost savings can be achieved while maintaining or increasing operational readiness.

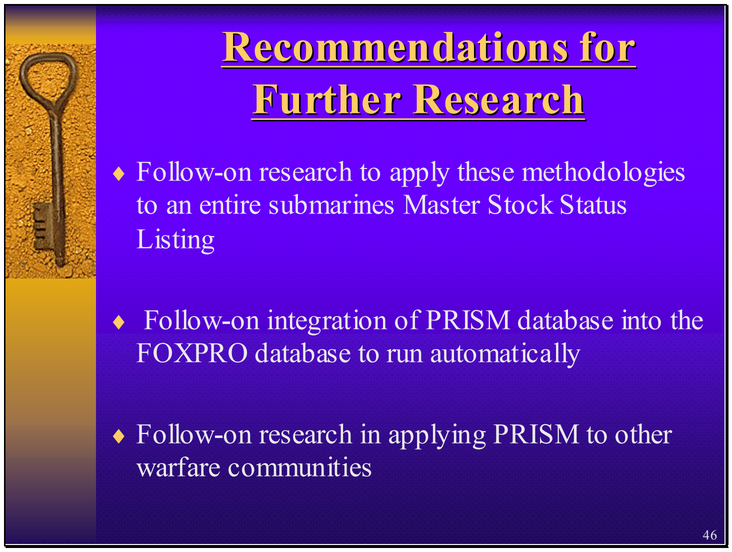
First, the PRISM report and its design (via excel spreadsheet) provide managers a set of tools intended to assist in making inventory decisions. With a wide range of information, the PRISM report adds essential flexibility managers' need for smart inventory decision-making. Second, on average, the PRISM simulation utilizing Crystal Ball allows a reduction in the inventory level on board a submarine while maintaining the same level of parts readiness. The simulation facilitates determination of the optimum level of the inventory based on duration of the deployments, usage rate, and protection level. It also highlights spare parts that are under-stocked. Overall, PRISM will improve logistical efficiencies, reduce inventory onboard submarines, reduce costs, and provide more flexibility than the current process.

We highly recommend purchasing the site license for the Crystal Ball, or a comparable simulation program, to run the PRISM simulation. Since Crystal Ball can run a simulation model thousands of times, it is able to output a level of uncertainty around a probability in a given problem.

We recommend using the Poisson distribution tables as a secondary tool when Crystal ball is not available. The Poisson distribution tables achieve similar results; however, the tables do not provide the accuracy of the Crystal Ball simulation, especially after thousands of trial runs.

*Note: See Chapter IV, sections A, paragraphs 1-3.

Slide 46



Abstract: Recommendations for further research.

Briefing Script:

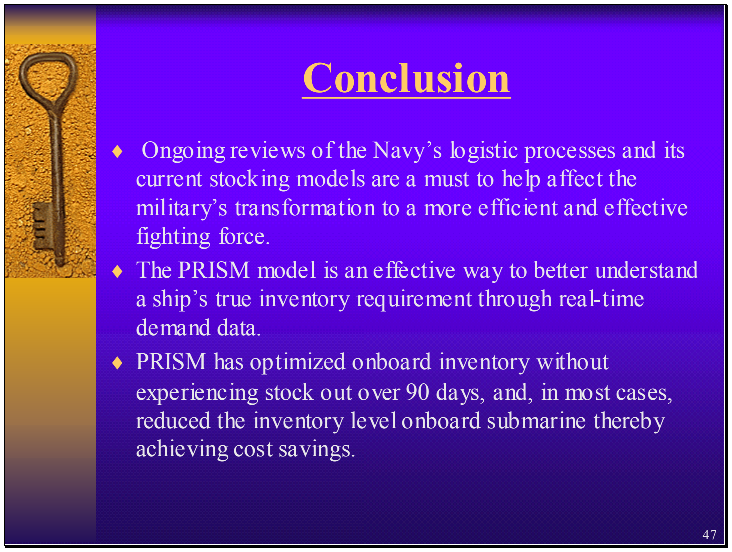
1. FLSIP provides stocking allowances for all repair parts onboard these submarines. It is therefore feasible to acknowledge the possibility that PRISM could run demand data against all repair parts assigned to a submarine. With usage rates provided by each submarine, Crystal ball could set a new target allowance for each item onboard, for each individual submarine, within the parameters set by CSP.

2. The equations and processes that enable us to predict allowances for a period of time can be accomplished in a timelier manner by implementing this program into one of the previously stated programs. Crystal ball works extremely well with Microsoft's' EXCEL spreadsheet program, and therefore can be created to tie in and run processes automatically, eliminating the human interface portion.

3. This endeavor may take a significant amount of energy and resources, but providing the other warfare communities with a better inventory management tool than they currently possess will be time and money well spent.

*Note: See Chapter IV, section B, paragraphs 1-3.

Slide 47



Abstract: Summary slide

I. INTRODUCTION

A. PURPOSE

Since 11 September 2001, the United States (**U.S.**) Military has operated in an extremely dynamic environment where combating asymmetric threats has strained available resources; personnel end strength has decreased 1.03%[1] over the past decade as compared to an ever-increasing Operational Tempo (**OPTEMPO**) over the same period. This dichotomy presents a quandary to the senior military leaders in terms of optimizing resources to meet increasing global requirements. With a seemingly perpetual engagement in the "War on Terrorism," it is imperative senior military management employ fiscal responsibilities in an effort to transform our forces to meet these new challenges.

This professional report will describe the current inventory stocking tool used by Commander Submarine Force U.S. Pacific Fleet (**CSP**) (Mission Essential Spares Support (**MESS**)), introduce a proposed demand based inventory management tool, Pacific Regional Inventory Stocking Model (**PRISM**), then compare the effectiveness of the two options. Our objective is to determine which model, MESS or PRISM, more efficiently optimizes inventory stocking levels precluding any negative resultants (e.g. reduced readiness).

B. HISTORY

1. SSN Operations

On April 11th, 1900, the face of naval warfare was forever changed with the delivery of the first ever British submarine built by John Holland. Considered a Revolution in Military Affairs (**RMA**), the Holland VI submarine quickly evolved as the weapon of choice throughout the 20th Century. Designed as a multi-mission platform, and capable of operating in forward deployed theaters, the Holland VI exercised U.S. policy, ultimately promoting our strength and will. Roughly 54 years later, another RMA occurred with the commissioning of the first nuclear powered submarine – U.S.S. Nautilus. Since the Nautilus,

[1] Department of Defense, DoD Active Duty Military Personnel Strength Levels Fiscal Years 1950-2002, <http://web1.whs.osd.mil/mmid/military/ms9.pdf>, accessed 22 May, 2003.

many submarine variants have followed, helping ensure the freedom and liberties we have grown accustomed to. Today, two distinct U.S. Navy submarine platforms exist, the SSN and SSBN (with the SSGN on the horizon), which are continuing the evolution and ensuring our countries sovereignty.

Developed from its roots, in 1954, with the launching of the Nautilus, the SSN fleet has emerged as a naval platform of choice. The SSN (fast-attack submarine) fleet consists of over 50 Los Angeles 688 class submarines, two Seawolf class submarines and one special operations submarine. SSN submarine mission profiles include anti-submarine and surface warfare, intelligence gathering, battle group escort, mining, cruise missile operations, special operations, and rescue/humanitarian operations.

The diversity in SSN mission profiles makes it very difficult to identify a single standard for operations. The OPTEMPO of an SSN traditionally consists of one six-month deployment every twenty-four months. In some cases the six month deployment is split into two three month theater deployments. The eighteen month turn-around period between deployments consists of one week to several months of operations composed of exercises, contingency operations, training and diplomatic missions in addition to those listed above. Additionally, the SSN will undergo an extended maintenance period call Submarine Refit Availability (**SRA**) during which major systems are repaired, replaced or updated. Approximately six months to a year before an SSN extended deployment, the ship will commence a work up, otherwise known as an extended training period, in which the crew and ship prepares and qualifies for the upcoming operations.

2. SSN Logistics Process

During a period of fiscal constraints and world events requiring U.S. participation in multiple theaters, it becomes increasingly necessary to maximize operational readiness with minimum negative logistical impacts. To achieve this, logistical support must identify the most effective product mix in terms of parts, maintenance schedules and system repairs, to prepare a submarine for both short and long term deployments. Logistics must be highly congruent with all systems to ensure it does not become a bottleneck within the critical path of the submarines effectiveness. In other words, failing to properly outfit a submarine, prior to deployment, could jeopardize critical missions and ship safety. This, perhaps, might be due to system failures where the submarine may not be correctly equipped to perform necessary repairs, requiring the boat to pull off station. Therefore, a need to properly prepare the submarine, in terms of stocking high demand parts prior to deployment, exists. The following section will identify the historical approach to the ongoing saga of the submarine logistical problem.

C. BACKGROUND

1. FLSIP Inventory Control System

The Navy's submarine fleet uses the Naval Inventory Control Points (**NAVICP**) Fleet Logistics Supply Improvement Program (**FLSIP**) inventory control system, which is based on the Coordinated Shipboard Allowance List (**COSAL**). The COSAL is that portion of the spare and repair parts inventory that is maintained onboard a ship or submarine and is sometimes referred to as onboard repair parts (**OBRP**).[2] The FLSIP inventory control system is based on the following equation:

$$\text{Usage Rate} = (\text{Population} * \text{Best Replacement Factor})/f$$

Here, "*Population*" is the number of times (frequency) a particular repair component or like item is installed in any onboard system (e.g., a periscope). The "*Best Replacement Factor*" (**BRF**) is an exponentially smoothed, annually forecasted replacement rate. BRF is based on both the initial failure rate data which is provided by the contractor, and the annual component failure updates (using historical demand data) collected through the Material Maintenance Management (**3M**) system for individual components.[3] Finally, the constant "f" represents the current FLSIP model measurement of part failures observed over

[2] Naval Supply Systems Command, NAVSUP PUB 485, ch. 4, p. 38, 2000.

the relevant period. The 3M system is a collection of monthly demand rates per submarine of requested repair parts used during the month.[4]

a. *.5FLSIP Plus*

The ".5FLSIP Plus" model, an iteration of the FLSIP stocking model, is currently used for the non-steam and electric, hull, mechanical and electrical parts (i.e., non-propulsion plant related parts which are hull, mechanical or electrical in nature) for the SSN-688 Los Angeles Class submarines. Once an allowance objective was established by FLSIP, any allowance candidate whose usage rate (**UR**) failed the .5FLSIP threshold criterion (one failure in two years) was deleted from the initial stocking inventory. In the .5FLSIP model, a part qualifying as a demand-based allowance item (item depth to satisfy 90 percent of demand over a 90-day period) must have an expected usage greater than once per quarter. Items with less than this expected usage but greater than once every two years qualify as insurance items for mission vital systems/parts and are stocked at a depth of one replacement unit. An *insurance item* is an essential item for which no failure is predicted through normal usage, but, if failure is expected or loss occurs through an accident, abnormal equipment/system failure or other unexpected occurrences, lack of an immediately available replacement would seriously hamper the operational capability of the weapon system. The "Plus" term refers to additional parts that are added based on casualty reports (**CASREP**) or 3M usage data or technical overrides.

b. *MESS*

Circa 1999, the PACFLT submarine supply management was the .5FLSIP program with an embedded node called the Mission Essential Spares Support (**MESS**) program. The MESS pre-deployment program utilized the FLSIP inventory control system used by both ships and submarines within the United States Navy. In total, these programs analyzed approximately eight critical submarine systems: fire control, sonar, periscopes, reactor, torpedo tubes, ballast control systems, electronic surveillance, and radio systems, which were identified by an Allowance Parts List (**APL**). The purpose of running the MESS program was to ensure a deploying submarine would

[4] Chief of Naval Operations, OPNAVINST 4790.4C, http://www.spear.navy.mil/3-M/.

have 100% parts support onboard for these critical systems prior to deployment. The MESS program was run and analyzed only once prior to deployment (to verify stocking levels at 100%) at the D–120 date. Once these parts were identified, the remainder of the days prior to deployment day was spent expediting them to the submarine for stocking.[5]

2. AVCAL

The aviation supply community uses an inventory control system called Aviation Coordinated Allowance List (**AVCAL**) to manage stocking levels for their respective aircraft. The AVCAL represents items that are required to maintain support of an Air Wing and its squadrons, again, based upon the FLSIP model. The AVCAL is a specific allowance of repairable items, subassemblies and repair parts which are required for support of the assigned aircraft. It is tailored in accordance with the maintenance profile of any big deck (e.g. LHD and CVN), and is designed to ensure maximum support effectiveness in a combat environment for a period of 90 days.

In comparison, where COSALs .5FLSIP Plus model uses an algorithm to determine a change in a submarine's inventory level, any additions to the AVCAL model incorporates consumer level requirements that are in agreement with the approved maintenance plan. The AVCAL process takes into account not only the particular ship's usage and demand data, but also the usage and demand data of like ships with the same type and number of aircraft (e.g. LHD versus LHD, CVN versus CVN). The deciding factor for a change in the quantity of repair components comes from the combination of an aviation repair component usage database and interaction with the supply manager. In reviewing additions to the AVCAL, the Navy's demand based model computes spare parts requirements one component at a time without regard to aircraft readiness or inventory cost. In other words, AVCAL's changes are based primarily upon raw demand data submitted by the various squadrons.[6]

D. COMMANDER SUBMARINE FORCE U.S. PACIFIC FLEET CURRENT EXPEDITING MANAGEMENT PROCESS

In 1999, CSP terminated the MESS node, desiring a different, more functional program to replace it. The follow on program would be capable of analyzing all systems and parts onboard a submarine versus only selected eight, mission critical items (MESS).

[5] Commander Submarine Force U.S. Pacific Fleet, CSPINST 4406.1E, Submarine Supply Procedures Manual.
[6] Ibid., 4-44.

The emergent program was to be a merger of two inventory control stocking theories , the AVCAL stocking theory and the current .5FLSIP Plus. This merger would take AVCAL's real time demand data theory and compare it to the .5FLSIP Plus stocking model data, depositing the resultant submarine usage rate into a FOXPRO database management system. This combinatory effect created a modified, all encompassing version of the old MESS. This process has since been utilized as an expediting tool in order to highlight high demanded items to be brought onboard prior to deployment day.

Four months prior to deployment (D-120), a submarine supply officer runs an outstanding requisition listing, identifying all repair components required by .5FLSIP Plus that are below the .5FLSIP allowance or the Selected Item Management (**SIM**) demand based high limit. After submission of the outstanding requisition reorder into the supply system, this listing is also submitted to CSP by the submarine which is then processed directly into the CSP FOXPRO database. This database houses a full two years worth of demand of repair parts from *like* platforms. i.e.: 688 Los Angeles class fast attack submarines from the Pacific Fleet. This compilation of data is drawn down from the Navy's 3M database system which collects monthly demand data from all submarines. The FOXPRO database then compares the submarines reorder listing against the demand of all submarines in the Pacific Fleet.[7]

The output derived from FOXPRO is in EXCEL spreadsheet format and compares demand data of the resident submarine against all like CSP SSN-688's. This tool utilizes two input variables, CSP Demand (**CSPDMD**) and a resident boats on-hand quantity (**OHQTY**), to determine the status of repair parts stock. CSP has deemed a CSPDMD of ten or greater ($\geq$ 10) as their measure, since any repair part that meets this criteria in addition to an allowance (**ALW**)[8] of zero is considered a high priority (**HI-PRI**) requisition. In other words, these items have a high demand usage rate without any required safety stock onboard. Upon identification and labeled HI-PRI, these requisitions will then be upgraded to the highest priority factor allowable by the supply system for a deploying SSN, priority 02 (**PRI 02**). Working in unison, the submarine supply officer, his immediate superior in command (**ISIC**), and the NAVICP will ensure all identified

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[7] Adam Black, *FOXPRO Database Information,* interview by Kurt Chivers, CSP Pearl Harbor, HI, March 31, 2003.
[8] ALW numbers are based upon the .5FLSIP model generated by NAVICP.

HI-PRI items are onboard prior to deployment day (D-0). Executed at four specific periodicities (D-120, D-90, D-60, D-30), this program identifies the requisite outstanding repair parts causing a supply re-order signal to be sent. At D-30, the submarine stops issuing repair components from its own onboard stock, in order to preserve their levels, and embarks on a free issue stocking program, where inter-ship transfers from non-deploying subs occurs.[9]

[9] George Aoki, *Repair Part Re-issuing Procedures Post D-30,* interview by Kurt Chivers, CSP Pearl Harbor, HI, March 31, 2003.

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II. PRISM DEVELOPMENT

A. OVERVIEW

Validation of PRISM will be conducted using baseline data provided by CSP Supply in the form of a MESS report. Information in the MESS report will be sorted and augmented to incorporate parts usage rate (based on individual ship), fleet demand rates (based on two year data for individual parts), and comparisons between ship stocking levels and demand levels. All augmentations will be conducted in the format of the original MESS report (Microsoft Excel) for each CSP submarine across each of its four pre-deployment requisition periods. Once augmented, the resultant report provides the PRISM dataset. After the PRISM dataset is constructed two separate models will be built to provide an analysis of optimal stocking levels and the effect on operational readiness and savings. The final PRISM product is a basic database that is constructed as a tool to assist managers (ship, squadron and fleet) in making inventory stocking decisions.

B. ORIGINAL MESS REPORT

As discussed in chapter one, the CSP MESS report utilizes two years of demand data maintained in a FOXPRO database. Recall, MESS is an enhanced inventory requisition expediting tool that analyzes captured demand data from the CSP Los Angeles class submarine community (SSN-688), and compares it to the combined yearly average demand data for a single CSP SSN repair components allowance. Figure 1 below provides an overview of the MESS spreadsheet and includes descriptions of each column. The following information provides details used in assessing CSP's MESS.

Four months prior to a submarine deployment (D-120), the supply officer runs his outstanding requisition listing. This is a listing of all repair components required by .5FLSIP Plus that are below the high limit and need reordering. A copy of this listing is aggregated into CSP's FOXPRO database, where comparisons are made, and critical repair components are highlighted by MESS. The FOXPRO database houses two years worth of all CSP SSN 688 repair part demands. Essentially, the FOXPRO database output (MESS report) compares an individual submarine's reorder listing against the demand of all submarines in the Pacific Fleet.

The MESS report is initially sorted and used as follows to identify high demand parts relative to individual ship stock levels. First, the report is sorted by CSPDMD, in descending order, and then again by the ships OHQTY, this in ascending order. This report can be quite long, so the report cutoff is taken at those parts that have a CSPDMD of 10 or greater, and serves as the report cutoff point.

Once the data is sorted, a final MESS report is produced which is then used as a requisition expediting tool. The report is useful in its current form, providing valuable static information to inventory managers. However, usefulness of the data contained in the MESS report can be further enhance by manipulating and augmenting the data in a manner that allows managers to identify key decision variables. The next section discusses how the PRISM report data is manipulated and augmented to produce such a management tool.

Figure 1: MESS/PRISM – Section 1

RI	COG	NIIN	QTY	UIC	JD	SERI	SUF	SUPADR

RI = Routing Identifier, a code of who is going to receive the requisition
COG = Cognizant Manager, a code of who owns the material and stocks it
NIIN = National Identification Item Number includes the NSN (Nat'l Stock Number)
UIC = Unit Identification Code Each ship/sub in the US military has this ID'ing them
JD = Julian date
SERI = Serial number which is assigned to a requisition
*Note: that the UIC, JD, and SERI make up the requisition number.
SUF = Suffix code, used to distinguish separate supply actions under a single document. They are assigned by activities processing MILSTRIP/MILSTRAP transactions.
SUPADR = Supplementary Address usually assigned by the ship to identify where the part is to be stored

FC	PRJ	PRICE	STATLINE	LCAV

FC = Fund Code used for financial reporting, indicating what whether the part is a repairable, consumable, medical, etc.
PRJ = Project code, identifies requisitions, shipments, and related documentation to special projects, operations, exercises, and maneuvers
STATLINE = Status line, lists the latest status of the part
LCAV = Logistics Customer Asset Visibility provides visibility of material receipt and delivery information to fleet customers, improves the Navy's Stock in Transit tracking process, end records, and reports on logistics report time

SHIPDMD	SHIP2YRAVDMD reqns	SHIPUSRT PARTS/QTR	SHIPQTY	CSPDMD	AV2YRDMD reqns	QTRAVDMD Parts	CSPQTY

SHIPDMD = Total ship demand data, the number of times ordered
SHIP2YRAVDMD reqns = Ship average parts per requisition (based on two years data) (**PRISM**)
SHIPUSRT PARTS/QTR = Ship use rate for specific part (90 day period) (**PRISM**)
SHIPQTY = Total ship qty ordered for total of all demands
CSPDMD = COMSUBPAC Demand for all subs in PACFLT, the total number of times ordered
AV2YRDMD reqns = Average parts per requisition at CSP level (based on two years data) (**PRISM**)
QTRAVDMD Parts = Average number of parts demanded per ship in CSP (based on two years data) (**PRISM**)
CSPQTY = CSP total qty ordered for all fleet submarine (total demand)

APL	EFD	COSAL	SIM	ALW	OHQTY

APL = Allowance parts list, a number given to each piece of equipment onboard a ship
EFD = Equipment Functional Description
COSAL = Coordinated Shipboard Allowance List (HM&E = Hull, Maintenance, and Electrical, Q = Nuclear) for our reports, its all HM&E, designated H
SIM = Selected Item Management; the R-supply computer will manage fast moving items, and if a part has 2 hits within 6 months, it qualifies for SIM, and gets its own High/Low limit. The part will only need to have one hit within 12 months to remain a "SIM" item.
ALW = Allowance, the FLSIP computed quantity that is stocked onboard
OHQTY = On-hand Quantity, the actually quantity that is currently onboard the sub

C. PRISM REPORT

The PRISM report continues to build upon MESS data provided by CSP, and provides the backbone for constructing the models used in the validation and analysis portions of this report. The basic PRISM report is comprised of (augmented MESS report, inventory comparison and cost analysis), each of which will be describe in the following sections.

As previously described, the PRISM report is an augmentation of the Microsoft Excel MESS spreadsheet utilized by CSP. Specifically, four columns are added to each ship's original MESS report; ship average parts per requisition (**SHIP2YRAVDMD reqns**), average ship quarterly parts usage rate (SHIPUSRT PARTS/QTR), CSP average parts per requisition (**AV2YRDMD reqns),** and the average parts usage per quarter per ship across CSP (**QTRAVDMD Parts**). The four columns are illustrated as highlighted columns in Figure 1.

The first column, QTRAVDMD Parts, provides the base calculation used in the PRISM analysis to compare individual ship stocking levels, based on requisitions made during the work-up period, against the demand for individual parts across CSP. QTRAVDMD is the output of CSPQTY divided by CSPDMD, divided by 8 (8 quarters per two years), and divided by the number of SSNs in CSP (26), as seen in the following equation:

$$\textbf{QTRAVDMD} = \frac{\text{CSPQTY}}{\text{CPSDMD * 8 * \#SSNs in CSP}}$$

This output shows the raw average parts usage rate by all CSP fast attack submarines over a 90 day period.

Ship usage rate (**SHIPUSRT PARTS/QTR**), is the second augmentation made to the original MESS data in constructing the PRISM report. SHIPUSRT evaluates the quantity of a specific part demanded by an individual submarine over a 90-day period. The following equation is used to calculate SHIPUSERT:

$$\textbf{SHIPUSRT} = \frac{\text{SHIPQTY}}{8}$$

Ship Quantity (**SHIPQTY**) represents the total number of parts requested by a specific submarine over a two year period. This number is then divided by eight to provide an average quarterly usage rate that will be used to evaluate ship stocking levels versus CSP demand over a 90 day deployment cycle.

The final two columns, which comprise the PRISM augmentations, relate to identifying the average parts per requisition at both the ship and CSP level (SHIPAV2YRDMD and AV2YRDMD reqns). These columns represent the number of a specific part demanded per requisition over a 24-month period. Requisition information presented in this manner provides the supply officer and inventory managers with a historically based snapshot of economic reorder quantities. This data can then be utilized to reduce ordering costs, man hours required for stocking, and opportunity losses due to excess parts warehousing.

D. QTRAVDMD vs. ALW

Once QTRAVDMD quantities have been determined, a comparison of these quantities is made relative to the deploying submarines FLSIP determined ALW. Any significant deviation in ALW, as compared to QTRAVDMD, requires attention. Specifically, the comparison allows management decisions to be made with respect to operational readiness, cost, and mission essentiality of a particular part. For example, if the supply officer determines the ALW is below QTRAVDMD (i.e. 2 components for ALW vs. 4 for QTRAVDMD), the supply officer could specify the part ALW as a possible candidate for adjustment. The supply officer can then make the decision to increase his ALW or maintain the status quo.

E. QTRAVDMD vs. OHQTY

The second and third portions of PRISM include sections which compare the OHQTY of parts (specific for each individual submarine) to the QTRAVDMD quantities of each part fleet-wide. Each portion is designed to assist the Supply Officer and Commanding Officer (**CO**) in making inventory vs. budget decisions.

Section two of the PRISM report focuses on evaluating current ship OHQTY levels against QTRAVDMD and identify parts carried at levels below QTRAVDMD (see Figure 2). Additionally, shipboard allowance levels are compared against CSP QTRAVDMD at the 100%, 75%, 50%, and 25% quartile levels. The purpose of this section is to identify if 1) shipboard allowance levels are below the specified quartile QTRAVDMD level, and 2) the dollar costs required to increase shipboard allowance to the evaluated level. Following the itemized evaluation of each part in section two, values are aggregated and reported for the dollar costs for adjusting allowances to specified levels, and a count of the items which are carried onboard at an allowance level below a particular QTRAVDMD quartile.

Figure 2: PRISM – Section 2

	AC	AD	AE	AF	AG	AH	AI	AJ	AK
1	BAL	ALW<100%(QTRAVDMD)	Add'l Costs	ALW<.75(QTRAVDMD)	Add'l Costs	ALW<.5(QTRAVDMD)	Add'l Costs	ALW<.25(QTRAVDMD)	Add'l Costs
2	OK	no	N/A	no	N/A	no	N/A	no	N/A
3	OK	no	N/A	no	N/A	no	N/A	no	N/A
40	OK	YES!	1.80	no	N/A	no	N/A	no	N/A
41	OK	no	N/A	no	N/A	no	N/A	no	N/A
42	OK	no	N/A	no	N/A	no	N/A	no	N/A
43	OK	no	N/A	no	N/A	no	N/A	no	N/A
44	2	3	$ 49.55	2	$ 31.95	2	$ 16.15	2	$ 0.36

BAL = Displays "OK" if OHQTY greater than QTRAVDMD
ALW<X%(QTRAVDMD) = Yes! or no if shipboard ALW is < specified quartile level of QTRAVDMD as listed in column label
Add'l Costs = The dollar amount required to purchase required parts to raise allowance to specified quartile level of QTRAVDMD

Section three of the PRISM report compares QTRAVDMD levels for each stocked part against the OHQTY maintained on-board the individual SSN at the time of the requisition report (see Figure 3). This section provides a report of the percentage amount the OHQTY varies from QTRAVDMD at evaluated quartile levels. Additionally, section three provides dollar savings and the associated inventory adjustments required to achieve a stocking level matching CSP observed demand at each quartile level.

The PRISM report provides managers, shipboard and shore side, a set of tools designed to assist in making inventory decisions. By weighing parts requisition requests against real-time demand data (represented by QTRAVDMD and SHIPUSRT), managers are empowered to make informed parts stocking decisions. Managers can submit requisitions with operational readiness, budgetary, and opportunity cost considerations fully visible.

The PRISM design enhances flexibility, providing managers with a range of information designed to assist with inventory decision-making. Specifically, it provides decision makers the ability to tie parts requisitions to mission criticality. Additionally, individual managers are provided information allowing them to tailor requisitions based on their confidence levels through the inclusion of several stocking level options (represented by QTRAVDMD quartile levels). The report presents information snapshots on the status of shipboard inventory overstock/understocks when evaluating ship readiness for pending deployment periods. Finally, as seen in the following sections, PRISM provides a backbone for the creation of robust models which can evaluate real-time demand data, inventory stock levels, and their effect on operational readiness.

Figure 3: PRISM – Section 3

	AJ	AK	AL	AM	AN	AO	AP	AQ
1	**% Overstock***	**100% Savings**	**QtyDec**	**75% Savings**	**QtyDec**	**50% Savings**	**QtyDec**	**25% Savings**
2	3647%	$ 10.68	118.71	$ 8.01	89.03	$ 5.34	59.36	$ 2.67
3	666%	$ 3.52	17.60	$ 2.64	13.20	$ 1.76	8.80	$ 0.88
4	923%	$ 6.05	21.62	$ 4.54	16.21	$ 3.03	10.81	$ 1.51
5	81%	$ 95.60	5.08	$ 71.70	3.81	$ 47.80	2.54	$ 23.90
53	0%	n/a	-1.25	n/a	-0.94	n/a	-0.63	n/a
54	287%	$ 1,713.76	4.91	$ 1,285.32	3.68	$ 856.88	2.45	$ 428.44
55	150%	**$ 44,706.47**		**$ 33,529.86**		**$ 22,353.24**		**$ 11,176.62**

% Overstock = Percentage OHQTY exceeds the 24 month CSP AVYRDMD quantity
X%Savings = Dollar amount of savings if OHQTY reduced to specified quartile level of QTRAVDMD; Aggregate total listed at bottom of each respective column
QtyDec = The unit quantity of each part reduced to achieve evaluated quartile level of QTRAVDMD

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III. PRISM VALIDATION AND INVENTORY SIMULATION

As identified in the problem statement, a requirement has been identified to include real time demand in order to adequately predict the stocking level necessary to maximize the operational readiness over a 90-day deployment period.

A. PURPOSE OF SIMULATION

The comparison of PRISM as an inventory management tool versus MESS and the .5 FLSIP determined levels was accomplished by using the Crystal Ball® simulation program. The purpose of the simulations are to determine how many individual repair parts, deemed mission critical based upon high demand, are required by a submarine in order to stay on patrol for 90 days without experiencing a stock out.

The results of the simulations were utilized to determine which management tool contains a more efficient inventory level.

B. SIMULATION SOFTWARE PACKAGE

Crystal Ball® 2000 Standard is an easy-to-use simulation program that assists in analyzing the risks and uncertainties associated with Microsoft® Excel spreadsheet models[10]. The Crystal Ball® software was chosen for several reasons:

- It allows the incorporation of all assumptions made for simulation purposes
- It can be utilized with Microsoft Excel, which is an IT-21[11] standard for all U.S. governmental agencies, as an embedded tool package
- It allows multiple replications as needed to avoid randomness
- It incorporates a confidence level for data sensitivity analysis
- It provides a means of analyzing data by utilizing dissimilar distributions exclusive of the probability distribution functions.

C. ASSUMPTIONS

The following assumptions represent the foundation for the design, execution, and analysis of the simulations associated with this project:

1. The simulation was prepared for mission critical spare parts with a demand of 10 or greater and a current zero on-hand inventory quantity.[12]

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[10] http://www.crystalball.com/crystal_ball/index.html, May 15, 2003

[11] INFORMATION TECHNOLOGY FOR THE 21ST CENTURY, GENADMIN/CMC WASHINGTON DC, DTG 061900Z APR 98.

2. The maximum submarine deployment cycle is ninety days without a re-supply. A period of ninety days was chosen based upon historical information provided by CSP Supply Department and is chosen for the worse case scenario application.
3. Within the context of the Crystal Ball® software, assumptions represent the probability distributions utilized in creating and analyzing simulations. Because individual part failures are random in nature and difficult to predict, the Poisson distribution was chosen as the baseline assumption. This distribution involves counting the number of times a random event occurs during a fixed time period; i.e., distance, area, etc. For the purpose of this analysis the mean used in the Poisson distribution equates to usage rate for a particular part over the evaluated period.
4. To estimate the desired inventory level, a minimum protection level of 99.99% was set for each repair part as one input variable for Crystal Ball® simulation.
5. All spare parts are considered independent of one other, equally mission critical, and non-repairable onboard the submarine.

D. POISSON DISTRIBUTION

The Poisson distribution is a one–parameter, discrete distribution that takes into account non-negative integer values. The parameter, λ, is both the mean and the variance of the distribution.

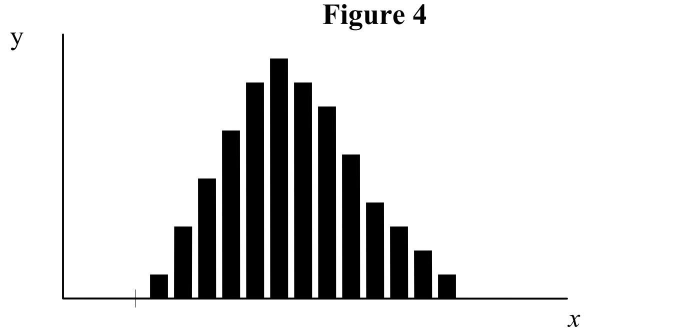
The distribution mass function for Poisson distribution is:

$$y = \frac{\lambda^x}{x!} e^{-\lambda}$$, where λ, is the sample mean, and $x = 0,1,2,3\ldots$

Graphically, the Poisson distribution, with λ as the sample mean, can be presented as:

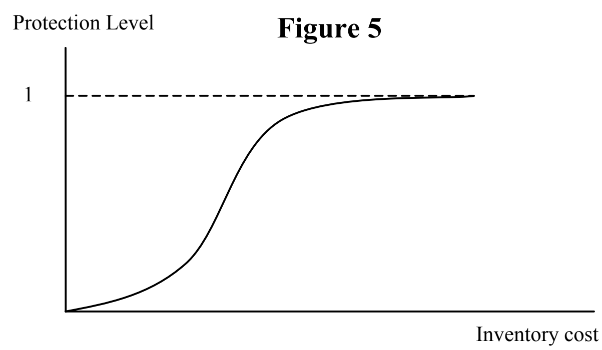
[12] Mission critical spare parts are defined as those parts that, if failure should occur, would cause a submarine to come off-station in the event of an inventory stockout.

Figure 4



This service (protection) level can be varied based upon the decision made by a Supply Officer assigned to a particular submarine. The distribution of cost vs. protection level is generally illustrated in Figure 5. The inventory cost exponentially increases as the protection level approaches 1.

Figure 5



E. CRYSTAL BALL® SIMULATION

1. Simulation Description

The following section describes the process and design of the simulation used to evaluate demand data applicability for inventory stocking decisions. As discussed, the Crystal Ball® simulation add-on to Microsoft Excel was used to run the stocking simulations. Figure 6 below describes the columns and the functions present in each spreadsheet, as they apply to the simulation. Simulations are run for each individual submarine during respective workup requisition reviews. The simulation data and assumptions are further augmentations of the original MESS reports, and use the previously described PRISM datasets (see Chapter II).

Figure 6 -PRISM Simulation – Section 4

DUSRT	FUSRT	PAVDMD	QTRAVDMD Parts	ALW	CALW	MIX	CMIX	ALW-MIX

DUSRT= Defined by Crystal Ball usage rate
FUSRT = Forecasted usage rate
PAVDMD = Predicted average demand based on confidence level and the usage rate
QTRAVDMD Parts = Average number of parts demanded per ship in CSP (based on two years data) (**PRISM**)
ALW = Allowance, the FLSIP computed quantity that is stocked onboard
CALW = Cost of the stored parts based on their quantity and price per item.
MIX = Number of parts that needs to be on board according to the PRISM allowance calculations
CMIX = Cost of parts that needs to be on board according to the PRISM base on quantity and cost of the item.
ALW-MIX= indicates the difference between .5FLSIP allowance and PRISM allowance

Cost	Check point	PRISM ACPL	FLSIP ACPL

Cost = Cost of difference between .5FLSIP allowance and PRISM allowance
* negative cost means the need to increase the allowance which requires indicated amount
Check point = gives recommendation to increase the allowance in case if it doesn't meet the enquired level of readiness with given usage rate.
PRISM ACPL = actual protection level under the PRISM inventory management tool.
.5FLSIP ACPL = actual protection level under .5FLSIP inventory management tool

2. Procedure

a. Data was sorted based on the price per item from high to low.

b. We define an assumption about our usage rate over the 90-day underway cycle in the cell Defined Usage Rate (DUSRT). By defining a usage rate in Crystal Ball®, we determine the distribution function (Poisson distribution) and the mean for this particular function (usage rate).

c. The definition of the Forecasted Usage Rate (FUSRT) cell was used as the forecasted parameter in the simulation. This parameter is required by the Crystal Ball® simulator.

d. The results of the simulation were placed in the Predicted Average Demand (PAVDMD) cell which consists of the formula:

CB.GetForePercentFN(forecast_cell_reference, percent), where

forecast_cell_reference is our FUSRT,

percent represents a minimum desired protection level

e. Cell QTRAVDMD gives us information about average quarterly demand for a particular spare part for all SSN-688 class submarines in the Pacific Fleet. QTRAVDMD was then compared with the Predicted Average Demand (PAVDMD) for a 90 day underway cycle. The result was made on the assumption that if the simulated PAVDMD was larger than QTRAVDMD, we used simulated PAVDMD, otherwise QTRAVDMD was utilized. The reason for choosing the larger of the two numbers is based upon maintaining the desired level of readiness.

f. The resultant comparison of the larger value of QTRAVDMD and PAVDMD was put in the cell named MIX. We believe that MIX is an optimal level of inventory that should be on board a submarine to maintain 99.99% protection level in our simulation. However, we assumed that the FLSIP cost of inventory was a budget constraint for the PRISM model. Based on that assumption, it was possible to find the optimum mix of inventory while staying within the budget constraint and reach the maximum possible readiness state.

g. We defined the cost of the inventory of the .5FLSIP allowance and PRISM simulation in cells CALW and CMIX.

h. We determined the total cost of inventory for .5FLSIP and PRISM.

i. We also found the differences in the level of inventory between .5FLSIP and PRISM and assigned a cost to this difference.

j. Actual Protection Levels (ACPL) for PRISM and .5FLSIP, given a particular periodicity (D-120/90/60/30), was derived through multiplying each individual ACPLs (e.g. ACPL1*ACPL2*….ACPLn = overall ACPL). Figure 7 identifies the overall ACPL for both PRISM (99.73%) and .5FLSIP (94.22%) following this procedure. The resultant states that an individual submarine will experience a PRISM stockout in 1 out of every 100 cases, while the same submarine would stockout more frequently (6 of every 100 cases) given an inventory stocked by .5FLSIP.

Figure 7 - PRISM Simulation –Section 5

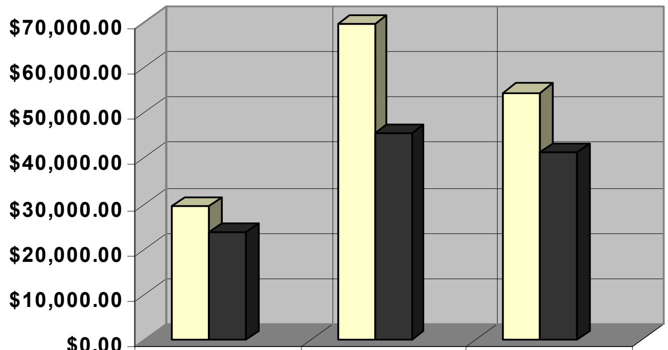
	A	B	C	D	E	F	G	H	I	J	K	L	M
1	DUSRT	FUSRT	PAVDMD	QTRAVDM D Parts	ALW	CALW	MIX	CMIX	ALW-MIX	Cost	Check point	PRISM ACPL	.5FLSIP ACPL
2	0.13	0.13	0.125	0.06	1	$1,173.00	0	$1,173.00	0	$0.00		100.00%	100.00%
3	0.13	0.13	3	0.12	3	$3,441.00	2	$2,294.00	1	$1,147.00		99.98%	100.00%
4	0.13	0.13	3	0.12	3	$3,441.00	2	$2,294.00	1	$1,147.00		99.99%	100.00%
5	0.25	0.25	4	0.08	1	$1,074.00	2	$2,148.00	-1	-$1,074.00	Recommended PRISM allowance increase	99.81%	97.46%
6	0.00	0.00	1	0.21	1	$830.50	1	$830.50	0	$0.00		100.00%	100.00%
7	0.13	0.13	3	0.21	3	$1,889.49	2	$1,259.66	1	$629.83		99.97%	100.00%
8	0.00	0.00	1	0.16	1	$566.89	1	$566.89	0	$0.00		100.00%	100.00%
9	0.00	0.00	2	0.12	1	$556.07	1	$556.07	0	$0.00		99.98%	99.98%
10	0.63	0.63	5	0.23	4	$1,927.04	5	$2,408.80	-1	-$481.76	Recommended PRISM allowance increase	100.00%	99.94%
11	0.25	0.25	3	0.17	3	$1,130.61	3	$1,130.61	0	$0.00		100.00%	100.00%
12	0.25	0.25	4	0.13	2	$715.18	4	$1,430.36	-2	-$715.18	Recommended PRISM allowance increase	100.00%	99.68%
13	0.00	0.00	1	0.73	2	$8.56	1	$4.28	1	$4.28		100.00%	100.00%
14	0.00	0.00	1	12.77	75	$300.00	13	$51.08	62	$248.92		100.00%	100.00%
28	1.75	1.75	8	2.69	121	$9.68	8	$0.64	113	$9.04		100.00%	100.00%
29	7.75	7.75	20	0.47	1	$0.00	20	$0.00	-19	$0.00	Recommended PRISM allowance increase	100.00%	
30					Total cost	$29,511.90	Total cost	$23,619.70	Savings	$5,892.20	Overall protection level for submarine	99.73%	94.22%

Check point = Displays "Recommended PRISM allowance increase" only if ALW < MIX
Total cost = Displays the dollar amount of inventory on board under .5FLSIP (CALW) and PRISM (CMIX) respectfully.
Savings = Displays the dollar amount that can be saved by using PRISM inventory stocking model
Overall submarine protection level= actual submarine protection level for a specific D-(120/90/60/30)

F. SIMULATION RESULTS

1. The cost of inventory depends on the service (protection) level chosen by the Supply Officer. The service (protection) level variant depends upon many factors, such as budgetary constraints (cost of the items), operating costs (cost of re-supply, delivery cost), and opportunity cost (cost of a mission failure). As an example, we utilized the data from the USS Pasadena to illustrate the advantage of PRISM versus the .5FLSIP in increasing the overall readiness while reducing inventory costs. Below, Figure 8 identifies comparative cost figures associated with both inventory stocking methodologies (PRISM and .5FLSIP) across pre-deployment periodicities. Each periodicity (D-120/90/60/30) identifies a pre-determined re-supply point, signaling the inventory management tool (PRISM or .5FLSIP) to send aggregated repair part information to the FoxPro database. Each look (D-120/90/60/30) categorizes an inventory readiness level with its associated cost. The noted differences can be attributed to the segmented nature of the periodicity as defined by .5FLSIP inventory management tool and explained in Chapter I.

Figure 8 -USS Pasadena cost of inventory comparison



	D-120	D-90	D-30
.5FLSIP	$29,511.90	$69,562.55	$54,498.55
PRISM	$23,619.70	$45,375.24	$41,299.14
Savings	$5,892.20	$24,187.31	$13,199.41

Overall protection level for USS Pasadena

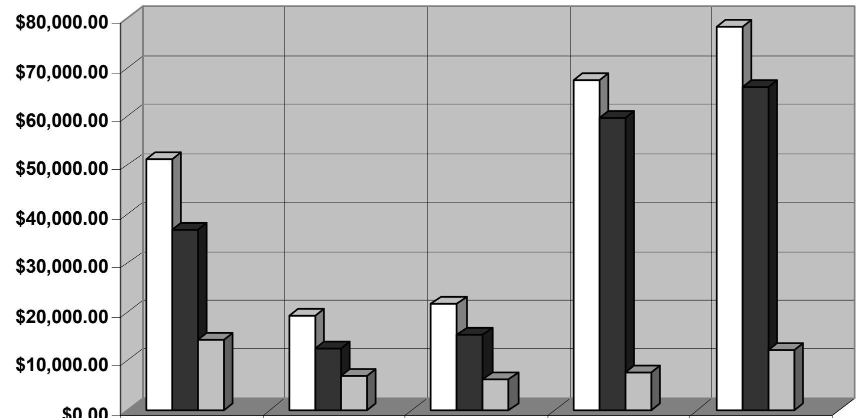
	PRISM	.5FLSIP
D-120	98.81%	90.38%
D-90	99.99%	79.19%
D-30	99.99%	30.94%
Average	99.60%	66.84%

	PRISM	.5FLSIP
D-120	98.81%	90.38%
D-90	100.00%	79.19%
D-30	100.00%	30.94%
Average	99.60%	66.84%

The results, provided in Figure 8, illustrate that more efficient resource allocation can be accomplished through the use of PRISM as compared to .5FLSIP. Evidenced by the comparative figures based on identical budgetary constraints, overall submarine readiness, determined through the implementation of PRISM, would reach 99.60% versus a .5FLSIP readiness level of 66.84%. A cost savings endemic to this more efficient inventory management tool accompanied this increase.

2. By using this simulation process, PRISM was found to be more efficient than CSP's current inventory management tool in that it provides for a reduction in the inventory level on board a submarine without experiencing a stockout over a 90-day period. Figure 9 shows comparative inventory costing results of five submarines based on both .5FLSIP and PRISM allowances. With the same budget that.5FLSIP utilized, a higher protection level was achieved.

Figure 9 - Comparison of MESS and PRISM based on average inventory cost



	USS Pasadena	USS Los Angeles	USS Olympia	USS Columbia	USS Chicago
.5FLSIP cost of inventory on average	$51,191.00	$19,332.32	$21,650.64	$67,509.96	$78,255.51
PRISM cost of inventory on average	$36,764.69	$12,449.86	$15,417.74	$59,764.83	$66,093.11
Savings on average	$14,426.31	$6,882.46	$6,232.90	$7,745.13	$12,162.40
Inventory cost reduction in percentage	28.18%	35.60%	28.79%	11.47%	15.54%

With employment of PRISM, inventory cost reductions in percentage were achieved for each boat. Specifically, a 28.18% reduction was captured by the USS Pasadena, 35.60% for the USS Los Angeles, 28.79% for the USS Olympia, 11.47% for the USS Columbia, and 15.54% for the USS Chicago. Additionally, an average (per boat) savings of $9,489.84 was identified by aggregating total savings then dividing this sum by the number of boats (in our case 5). Continuing this methodology across the entire CSP fleet (twenty-six fast-attack submarines), an average savings of $237,495.95 can be achieved. Furthermore, additional savings could be achieved by analyzing the entire onboard inventory using the PRISM inventory management tool as opposed to limiting our analysis to assumption 1.

In summary, PRISM allows the redistribution of the cost of inventory, thereby achieving a higher submarine readiness as opposed to .5FLSIP. It also provides a basis for Readiness Based Sparing (RBS) allowing the decision maker to redistribute inventory to meet the required budget and readiness constraints (e.g. manipulating the protection levels for spare parts for increased cost savings and/or readiness). Based upon the simulation results, the validation point was made that the PRISM inventory management tool is more efficient and cost-effective than .5FLSIP.

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IV. RECOMMENDATIONS AND CONCLUSION

A. RECOMMENDATIONS FOR IMPLEMENTATION

1. Based on the PRISM reports (excel spreadsheets) and simulation results in chapter three, we recommend implementing PRISM versus the current CSP process. A significant cost savings can be achieved while maintaining or increasing operational readiness.

First, the PRISM report and its design (via excel spreadsheet) provide managers a set of tools intended to assist in making inventory decisions. With a wide range of information, the PRISM report adds essential flexibility managers' need for smart inventory decision-making. Second, on average, the PRISM simulation utilizing Crystal Ball® allows a reduction in the inventory level on board a submarine while maintaining the same level of readiness. The simulation facilitates determination of the optimum level of the inventory based on duration of the deployments, usage rate, and protection level. It also highlights spare parts that are under-stocked. Overall, PRISM will improve logistical efficiencies, reduce inventory onboard submarines, reduce costs, and provide more flexibility than the current process.

2. We highly recommend purchasing the site license for the Crystal Ball®, or a comparable simulation program, to run the PRISM simulation. Use of the Crystal Ball® simulation program allowed the group to adequately predict a value based upon certain parameters due to the Law of Large Numbers. Since Crystal Ball® can run a simulation model thousands of times, it is able to output a level of uncertainty around a probability in a given problem. Using our project as an example, probability assumptions represent the uncertainty of whether or not a specific part will fail over a 90-day time span. Both CSP and the NSSC supply department can utilize the Crystal Ball® simulation package.

3. We recommend using the Poisson distribution tables as an alternative method when Crystal Ball® is not available. The advantage of using Crystal Ball® is that it can be accommodated when the demand for the inventory is non-Poisson distributed.

B. RECOMMENDATIONS FOR FOLLOW-ON RESEARCH

1. The PRISM project utilized data based upon mission critical, highly demanded items captured from the 3M database. This group recommends further research applying its theories to each individual submarine Master Stock Status List (**MSSL**). FLSIP provides stocking allowances for all repair parts onboard these submarines. It is therefore feasible to acknowledge the possibility that PRISM could run demand data against all repair parts assigned to a submarine. With usage rates provided by each submarine, Crystal Ball could set a new target allowance for each item onboard, for each individual submarine, within the parameters set by CSP.

2. This group recommends follow-on research to integrate PRISM and/or its concepts into the FOXPRO and/or 3M database, or use the FOXPRO/3M data to integrate into this group's own spreadsheets and database. The equations and processes that enable us to predict allowances for a period of time can be accomplished in a timelier manner by implementing this program into one of the previously stated programs. Crystal ball works extremely well with Microsoft's' EXCEL spreadsheet program, and therefore can be created to tie in and run processes automatically, eliminating the human interface portion.

3. The group recommends further research by other groups on whether PRISM can be applied to other communities, such as naval aviation or surface warfare. This endeavor may take a significant amount of energy and resources, but providing the other warfare communities with a better inventory management tool than they currently possess will be time and money well spent.

C. CONCLUSION

The environment of the Cold War era is quite unlike the operating environment of post 9/11 where uncertainty prevails in a world of increasing terrorism and asymmetric warfare. Our ship and submarine fleets are operating in a highly dynamic and up-tempo environment where shortened turnaround deployment cycles are now the norm rather than the exception. In addition, new technology implementation within the U.S. Navy's warships is expanding exponentially. The U.S. military must transition and transform to meet the challenges of the new millennium or risk losing its competitive military advantage. "If your environment is changing, you must change with it. If you don't, you perish."[13]

As a result of the post 9/11 environment and to affect our transformation to a more efficient and effective military force, ongoing reviews of our logistic processes and its current stocking models are required. Utilizing the PRISM model is an effective way to better understand a ship's true inventory requirement through real-time demand data, which FOXPRO (via the 3M database) already provides. Real-time demand has enabled the group to set benchmark usage rates, which is most useful when based upon newly installed systems. When these usage rates are compared to a deploying submarine, they highlight potentially inefficient stocking levels. PRISM, with its spreadsheets and simulations, will assist CSP and the Department of the Navy in its progress toward a more efficient and effective fighting force.

[13] Sahakian, Curtis. Strategic Alliances and Partnering Quotes: Change and Speed of Adaptation. http://www.corporate-partnering.com/info/strategic-alliances-and-partnerings-quotes2.htm, accessed 22 May, 2003.

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APPENDIX – PRISM DATABASE

A. INTRODUCTION

The U.S. Navy submarine force is arguably the most important operational segment in the fleet as the nature of operations lends itself to discontinuity in terms of utility. In other words, due to the "silent" nature of the submarine mission (e.g. submerged to protect location) any necessary requirements post D-0 would result in possible safety related issues inconsistent with policy. For example, when a boat leaves port, it must remain submerged to exploit its tactical advantage. If for some reason a particular repair part were not on-board and required for the safe evolution of the submarine, the boat would need to pull off station and restock. This makes the boat vulnerable and at risk to any number of safety related evolutions. These unnecessary risks, as they relate to repair part stocking, can be mitigated by effective employment of the PRISM. One specific utility derived from PRISM is a database that attempts to increase system wide functionality of Pacific Fleet stocking methodologies accomplished through "functional blueprinting."[14]

One potential output from PRISM is a menu driven database (**DB**) controlled by the user, where various objects serve as units of interest (in the context of this chapter, the acronym PRISM will refer to the database). Each object contains relational constraints which are enforced through the use of security and integrity methodologies, allowing the end user to derive information through programmable queries associated with his permissions level. The following will (1) identify a requirements analysis with assumptions, (2) give a brief description of relations, relationships and constraints, (3) provide a description of the system's inputs, outputs and user interface, (4) and discuss four areas of database administration (**DBA**) that apply directly to technical aspects of PRISM within a multi-user environment. Additionally, each form and report that was generated in the creation of PRISM will be discussed in terms of its functionality and usefulness.

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[14] Functional Blueprinting is a method whereby a database designer engages the end user to ensure terminal functionality is built into the model before work begins.

B. ASSUMPTIONS

1. Part information represents information carried at the fleet supply level. Stock item represents information at the ship level.
2. Inventory information is associated with a ship and a ship's deployment. This information is necessary for determining operational readiness as affected by stock outs.

C. REQUIREMENTS ANALYSIS

1. Stakeholders

The stakeholders in the system are the primary operators (submarine community Supply Corps Officers) and secondary users (senior leadership or operational readiness decision makers).

2. Report Requirements

The primary stakeholder requires reports which identify current on board quantity of mission essential spare parts that are requisite for the operation of a specific submarine.

The secondary stakeholder requires reports that will identify the demand for these mission essential parts (based on real time data of combinatory stocking and use information from the submarine fleet), and help forecast a realistic stocking level for each.

3. Query Requirements

The primary stakeholder requires queries such as inventory levels, demand levels, stocking history, and costs.

The secondary stakeholder requires queries such as those mentioned above in addition to off station time due to inadequate supply, readiness levels as compared to inventory level, and costs versus product mix ratios.

D. RELATIONS, RELATIONSHIPS AND CONSTRAINTS

Database design is a dynamic series of iterative improvements that increase functionality in the aggregate. To preclude implementation problems, the DB architect must ensure the blueprint is a viable baseline for project initiation. Figures 9-12 show four baseline models, (1) Entity Relationship Diagram (**ERD**), (2) Semantic Object Model (**SOM**), (3) Table/Column, and (4) Microsoft® Access Relationships which identify the relations, relationships, and constraints that were identified through the functional blueprinting process. Each diagram represents roughly the same material, however, these show a progression from blueprint to employment. In other words, we employed the ERD as our functional blueprint; applied the graphical concepts to Tabledesigner® (a tool for producing a SOM); ensured our model was represented in the 4th normal form (table/column); and transposed the SOM into a Microsoft® Access DB whereby the relationships were generated. The relationships represent the final product at the time of this project. The following will discuss the highlights of each model.

1. Entity Relationship Diagram

The ERD is graphical schemata used to represent entities and their relationships (see Figure 9). Entities are normally shown in squares or rectangles, and relationships are shown in diamonds. The cardinality of the relationship is shown inside the diamond.[15] Here, our attempt was to identify the entities[16] deemed necessary for DB implementation (i.e. ship, inventory, deployment, part). Within each entity, attributes[17] exist which describe what the entities consist of. For example, the entity *ship* has attributes *Hull Type*, *Ship Name*, *Hull Number*, etc… the values of which specifically identify that particular ship. Without attributes, the requisite level of specificity would not allow for proper DB implementation. Lastly, relationships[18] bridge the gap between entities. Each relationship has within it a minimum and maximum cardinality[19] which, in a binary relationship, identifies the number of elements allowed on each side of the relationship[20]. PRISM has four such relationships that further enhance model granularity.

2. Semantic Object Model

Next, we translated the graphics of the ERD into a SOM (see Figure 10) permitted through the functionality built into TD®. Here, each ERD entity, attribute and relationship/cardinality is transformed into its equivalent within TD® (i.e. object, data item, data group and object link attributes). This allows the user to further specify

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[15] David M. Kroenke, *Database Processing: Fundamentals, Design and Implementation* (Upper Saddle River, NJ: Prentice-Hall, 2002), 640.
[16] Entity: something of importance to a user that needs to be represented in a database
[17] Attribute: properties that describe the entities' characteristics
[18] Relationship: an association between two entities, objects, or rows of relations
[19] Cardinality: Maximum can be 1:1, 1:N, N:1, or N:M. Minimum can be optional-optional, optional-mandatory, mandatory-optional, or mandatory-mandatory.
[20] Ibid., p. 635.

granularity in addition to efficiently adjusting inputs into the most user friendly segments. Figure 10 shows five objects containing numerous data items describing that particular object. For example, ShipInformation contains items that describe the particulars of a ship. In this case, HullNumber, ShipName, Squadron and ShipType are all items that describe ShipInformation. Furthermore, HullNumber is annotated with a double asterisk ** (viewed in the vertical in TD®) that identifies that particular data item as the key[21]. As with the ERD, SOM also employs the cardinality principle as it specifies the number of allowable instances on either side of a two-way relationship, and whether an instance is required. Within ShipInformation, the key data item is HullNumber and is annotated with a cardinality or 1:1. This tells the DB designer that ShipInformation is identified uniquely by HullNumber and there will be one and only one instance of a particular HullNumber. To increase efficiency we are able to employ object links that allow us to create an association or relationship between a pair of objects in the same model. Once the link is created, links between objects appear as items in each object and when finally transposed into a DB, the links are represented by foreign keys or an intersection table.[22]

3. Table/Column

When the SOM is complete and nearly ready for DB implantation, it is imperative to ensure the model meets normal form[23] requirements. We ensured PRISM met the fourth normal form by requiring every multi-valued dependency to be a functional dependency. This can be seen in Figure 11 where we constructed the corresponding tables and columns relevant to our conceptual model. Here, each SOM object is identified as a bold-typed, upper case word prior to the parentheses. To the right of the parentheses is the key data item (identified in bold-type, lower case, underlined) followed by any simple data items (standard type), and any composite keys for the multi-valued data item (repeating group) relations. In order to comply with the 4NF requirement, we must create another table for our repeating group, SHIPINVENTORYITEM, where the keys become the key

[21] Key: a group of one or more attributes identifying a unique row in a relation. Because relations may not have duplicate rows, every relation must have at least one key, which is the composite of all of the attributes in the relation.
[22] Tabledesigner® help function
[23] Normal Form: A rule or set of rules governing the allowed structure of relations. The rules apply to attributes, functional dependencies, multi-value dependencies, domains, and constraints. The most important normal forms are the 1NF, 2NF, 3NF, BoyceCodd NF, 4NF, 5NF and domain/key normal forms.

of the object in which it is contained, in addition to the key of the group. This process helps minimize data anomalies within the DB.

4. Microsoft Access Relationships

Finally, when the model is ready for DB implementation, we again employ the functionality built into TD®, by using the create database function. This function takes the completed SOM and translates it into a viable Microsoft® Access Database. When complete, and the Access file is opened, a link to relationships becomes available (see Figure 12). Once opened, the relationship window is an immensely useful management tool whereby the DB manager can efficiently identify objects and their relations in both graphical and functional ways. As one can see from Figure 12, TD®, correctly transposed each object, data item and data link into their respective Access relationship table, and added a sixth table, ShipInventoryItem, which represents the data group embedded in ShipInventory. Access calls this an intersection table, where the primary keys for the table are the foreign keys of both ShipInventory and MasterPartsList. From this page, DB managers can add, remove or edit relationships (identified by the lines connecting the tables), to ensure the most efficient DB. For example, by double clicking on a relationship, the DB manager can choose to select referential integrity[24] which ensures the validity of relationships between records in related tables. PRISM employs this technique in addition to utilizing the cascade function that updates related fields and deletes related rows when the parent field or row is updated or deleted respectively. This further ensures that data integrity is maintained. Many other techniques were used to enhance the level of specificity within PRISM but are beyond the scope of this chapter. The following section will identify inputs, outputs and user interfaces designed to meet the requirements of dictated through the functional blueprinting process.

E. INPUTS, OUTPUTS AND USER INTERFACE

1. Inputs

PRISM was designed for multi-user functionality, which is to say whereas one end user will require a particular output, yet another may require something vastly different.

[24] Referential integrity is a system of rules that Microsoft Access uses to ensure that relationships between records in related tables are valid, and that you don't accidentally delete or change related data. *Microsoft Access Help Function.*

With this in mind, and with sound employment of the functional blueprinting process, we engaged upon selecting input screens (forms) that would allow the user to search, enter and modify data in a simplified, yet deliberate manner. Seen in Figure 13, the input screen permits the user to search for data by HullNumber, HullType, ShipName or Squadron. This level of granularity makes it less cumbersome for the user as he is not required to input all data about a particular boat, only the information he can recall. For example, if he can only recall the boat's name, but not the hull number, the DB can search on this single criterion. Of course, the DBA can set the security limits to whatever specifications they desire. When the input has been entered, the DB will search all related fields and return the information denoted in the Ship Details viewing pane. Currently, PRISM has twelve input screens that allow each user in a multi-user environment to obtain a great deal of information about all submarines in the DB. The twelve forms are divided between two specific groups of users (fleet and ship). These two groups require access to varying degrees of information and separate levels of granularity. Further explanation will be provided in the database administration security section.

2. Outputs

Information is power and managers demand accurate, timely information in the process of making effective decisions. Since gathering and compiling data is oftentimes costly and inefficient, leading to hasty and misinformed decisions, managers search for tools that will increase productivity. Microsoft® Access provides the capability of building reports which aggregate data into components desired by end users. Seen in Figure 14, output variables (APL, NIIN, Nomenclature, etc…) requested by the end user have been aggregated into a single report, identified by specific HullNumber or ShipName. The user can customize reports in a manner that is most efficient to him. This ability to customize pays rather large dividends in that a manager can make sound decisions based on vast amounts of data accessed through the casual data mining capabilities a DB allows. PRISM utilizes six outputs for the aggregation of reportable information. In order for these outputs to be compiled, the user must be able to navigate to the specific location. The following section will discuss the user interface employed by PRISM.

3. User Interface

PRISM is employed in a multi-user environment where two specific users have been identified. Data integrity remains a grave concern, so we have segregated the two users, employing the Principle of Least Privilege (**POLP**)[25] concept, allowing the fleet DBA to access the information pertinent to him (higher privilege) while limiting the ships DBA to only ship relevant data. Each user will enter the PRISM main menu, but preset privileges allow the fleet DBA to navigate through the entire DB using whatever control buttons he desires. The ship's DBA will be denied access to the fleet information, but be allowed to navigate the control buttons within the ship side. Each form has a control button that allows for easy movement to and from the main menu, to include a previous form button if the user entered the wrong screen. Upon exiting, the DB is automatically updated and saved. In a database environment, security and data integrity are very important; these and other administrative topics will be addressed next.

F. DATABASE ADMINISTRATION

1. Security Measures

In addition to server, directory, and file security, specific DB security measures are employed to ensure sound integrity is maintained throughout the entire model. PRISM employs a subject-based security protocol which will prevent unauthorized users from "adjusting" fields they do not have permissions for. Microsoft Access enables the DBA to set specific security protocols through implementation of the "user-level security wizard" function. This will ensure no DB replication within a multi-user environment as one must possess an administrative password to replicate the DB, change passwords, or change startup properties. The access privilege matrix shown in Figure 15 will provide the PRISM DBA with a functional chart allowing for a clean view of associated personnel and their permissions level.

2. Back Up and Recovery Procedures

A systematic backup plan is a necessary requirement for any DB. It is our belief that PRISM should utilize a backup plan that consists of the primary DB, a secondary or

[25] Principle of Least Privilege (POLP) is a computer theory that attempts to curb problems associated with giving access rights to everyone versus only those that truly need it. (J.D. Fulp, Professor Naval Postgraduate School).

mirror DB, a transaction log, and audit log as insurance against the four predominant failures associated with a Database Management System (**DBMS**): (1) transaction failure, (2) DB destruction, (3) system failure, and (4) erroneous transactions. Additionally, PRISM utilizes macro-defined control buttons that will force the user to save and close the DB upon completion. This is a specific recommendation, identified by Microsoft Access that should be employed within a multi-user environment. Lastly, checkpoints are used to "tag" specific transaction periodicities making recovery procedures timelier.

If a DB failure occurs and recovery is in order, PRISM employs rollback/roll forward procedures whereby a search for the last valid checkpoint within the transaction log ensues, restoring the DB to a point where all transactions are valid.

3. Resource Locking Policies

To prevent lost updates within the DB, PRISM employs the resource locking[26] functions available in Microsoft Access as they apply to the defined portion. In other words, PRISM is made up of two halves (Fleet Inventory and Ship Inventory) where each will have its own specific locking features specific.

The Fleet Inventory Management portion of PRISM employs explicit locks[27] with low granularity as the system will be accessed by a number of users. This way, it is less likely that there will be a conflict that would prevent the disparate users from completing their query or transaction. Additionally, share locks[28] are used to prevent data in the DB from being changed by others users until the lock is released. This will ensure the end user receives the exact number of parts that his transaction identified. This is imperative for operational commands, since a part with an MEC code of 1 (very important), not on the ship when requested, can seriously hamper operational readiness.

The Ship Inventory Management portion of PRISM employs implicit locks[29] with high granularity as the system will be accessed by a single user aboard the particular ship. Here, no conflicts will arise as a single user will not be in competition with anyone else for the data inherent to his ship. Additionally, exclusive locks are used in order to

[26] Resource Locking: the process whereby resources lock while a query is in action. This prevents multiple users from simultaneously accessing the same resources thereby preventing the possibility of a lock out, misinformation, or denial of service (DoS).
[27] Explicit lock: A lock requested by a command from an application program. (Kroenke p. 640)
[28] Share lock: A lock against a data resource in which only one transaction may update the data, but many transactions can concurrently read that data. (Kroenke p. 651)
[29] Implicit lock: A lock that is automatically placed by the DBMS. (Kroenke p. 642)

prohibit all sharing of the resource by any other user. Our vision is that the Supply Officer aboard U.S.S. Pasadena will be in control of his database, only sharing with those specific personnel that he chooses.

4. Transaction Processing Considerations

A DBA must be acutely aware of the transactions that occur within his/her DB and how even simple, logical operations can corrupt an entire DB. "A batch transaction guarantees that information in the database is logically consistent at all times, even when a single logical operation contains multiple database operations."[30] PRISM ensures the batch transaction function of MS Access is enabled so as to help prevent any DB integrity issues. As the creators of PRISM, we set the Batch Updates property to Yes, allowing the value of Commit On Close to be set to Yes and Commit On Navigation set to No. This will force the user to commit only when the form or main form is closed, or a user clicks the Save All Records command on the records menu. Ultimately this will provide consistency and recoverability of DB transactions in case of a system failure increasing overall reliability and integrity of the vast amounts of data.

[30] Microsoft Access Help function

Figure 10: Entity Relation Diagram for PRISM Database

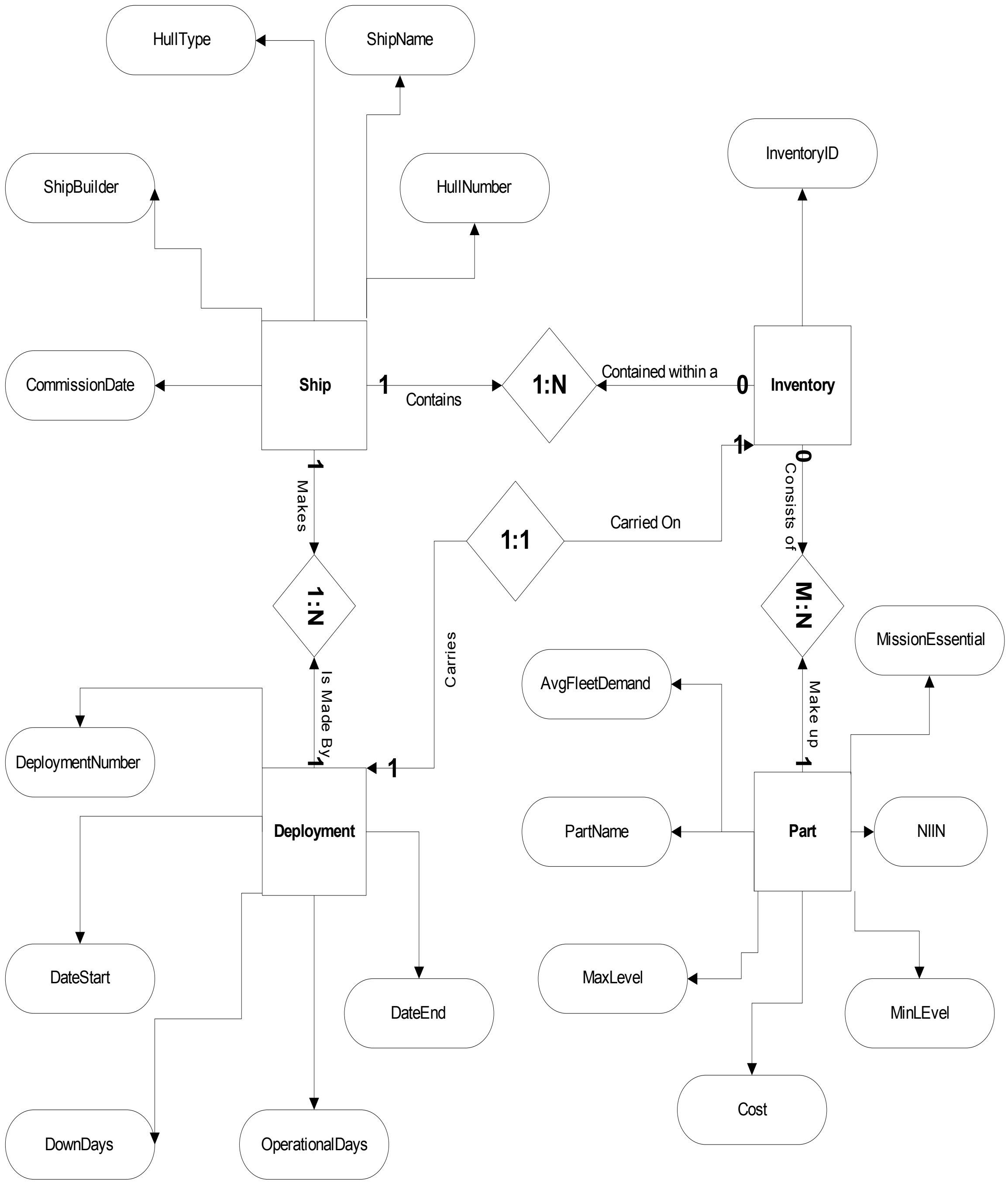


Figure 11: Semantic Object Model for PRISM Database

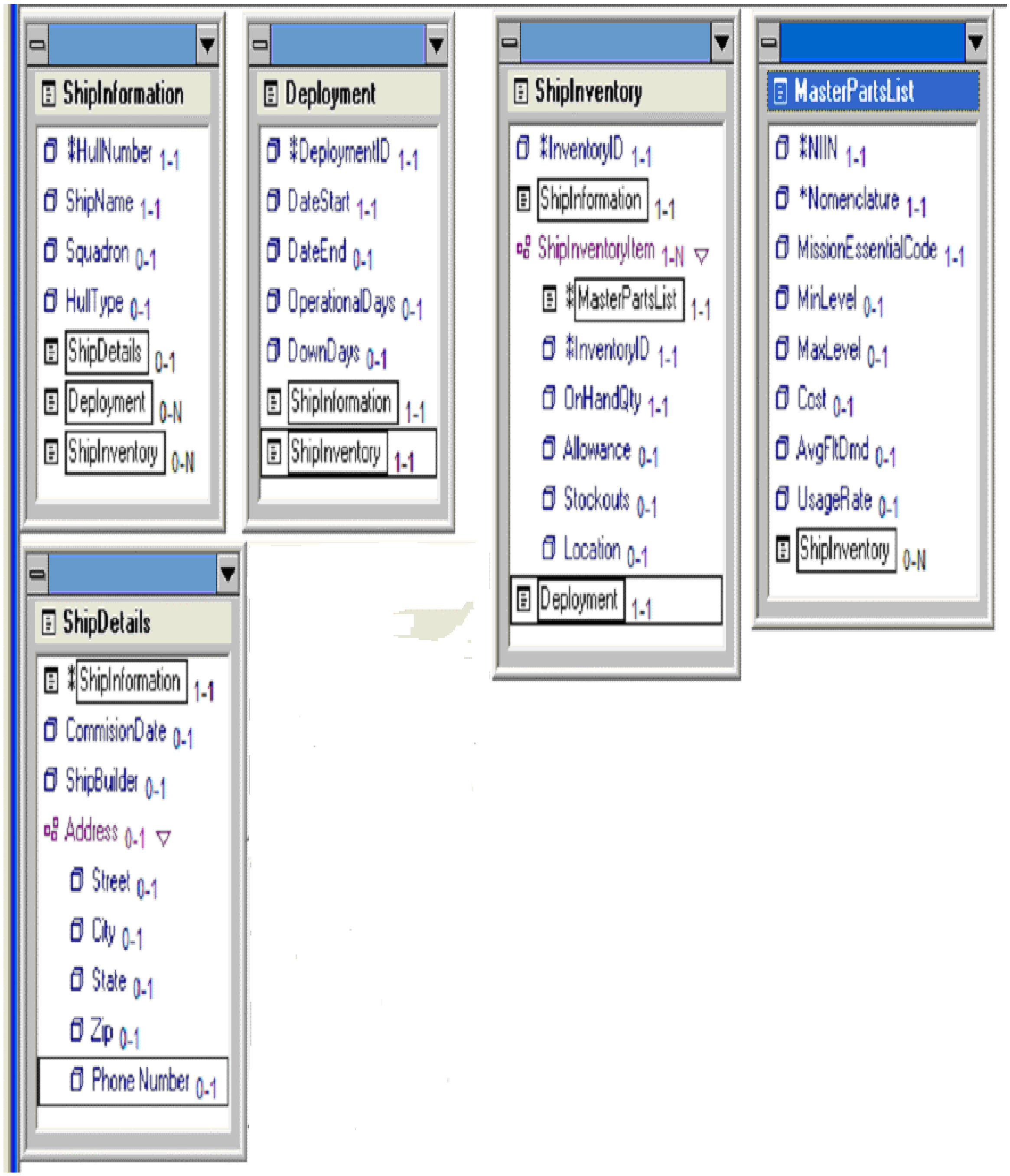


Figure 12: Table/Column for PRISM Database

SHIPINFORMATION(HullNumber, HullType, ShipName, Squadron)

DEPLOYMENT(DeploymentID, DateStart, DateEnd, OperationalDays, DownDays, ShipHullNumber_FK, InventoryID_FK)

SHIPDETAILS(HullNumber_FK, CommisionDate, ShipBuilder, Street, City, State, Zip, PhoneNumber)

MASTERPARTSLIST(NIIN, Nomenclature, MaxLevel, MinLevel, MissionEssentialcode, AvgFltDemand, Cost, UsageRate)

SHIPINVENTORY(InventoryID, HullNumberID_FK, DeploymentID_FK)

SHIPINVENTORYITEM(NIIN_FK , InventoryID_FK, OnHandQty, Allowance, Stockouts, Location)

Figure 13: Microsoft Access Relationship for PRISM Database

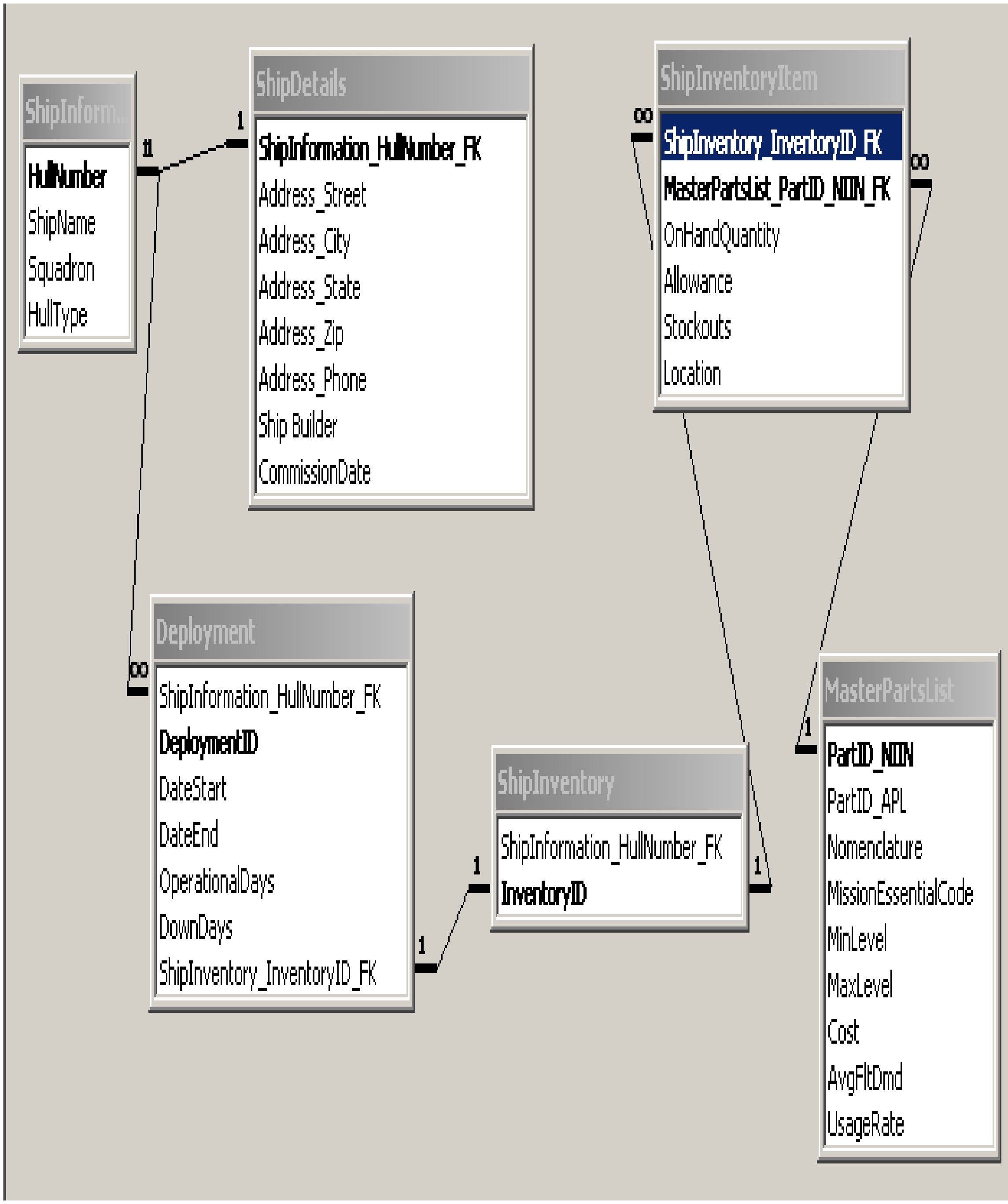


Figure 14: Example Input Screen for PRISM Database

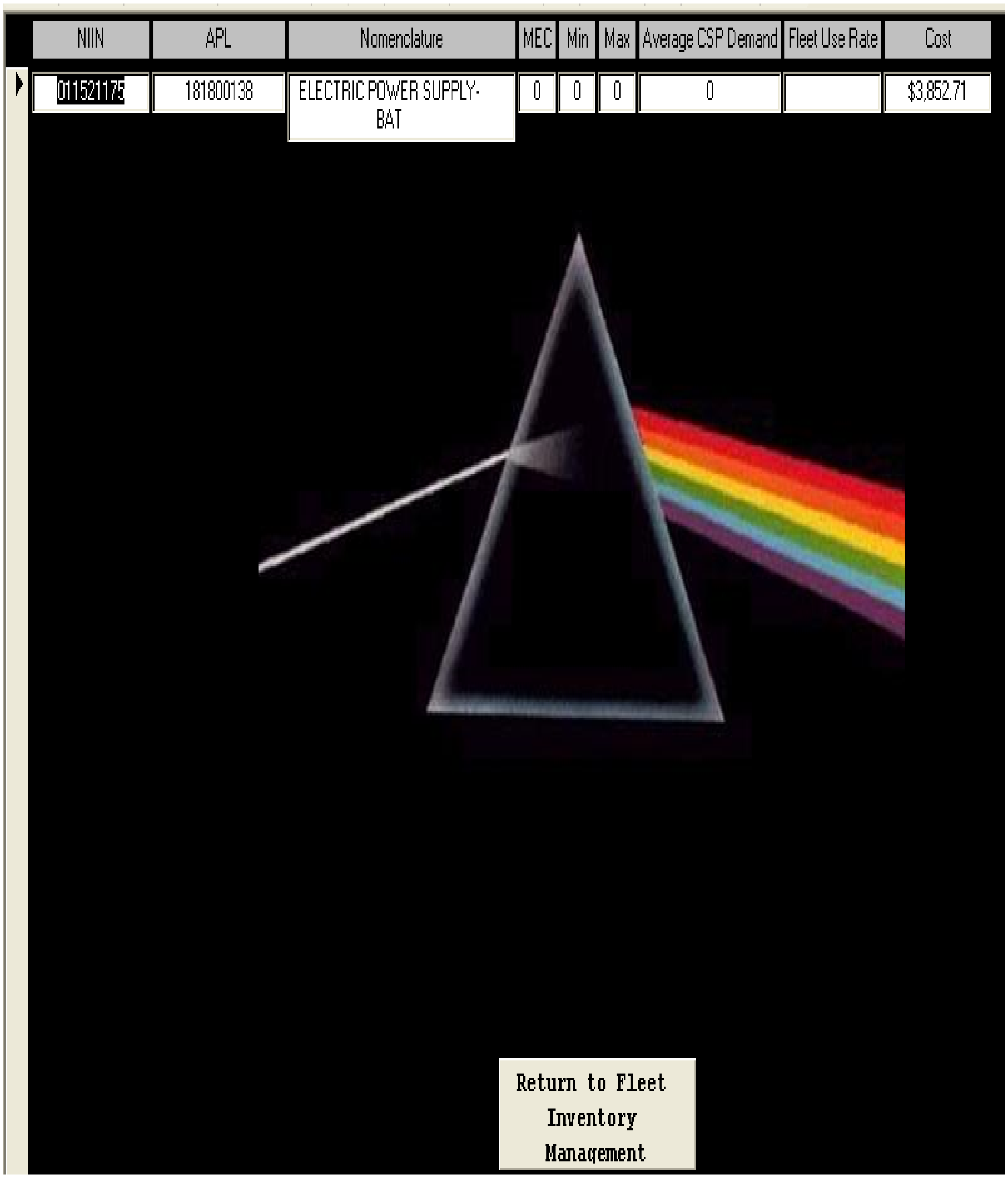


Figure 15: Example Output Screen for PRISM Database

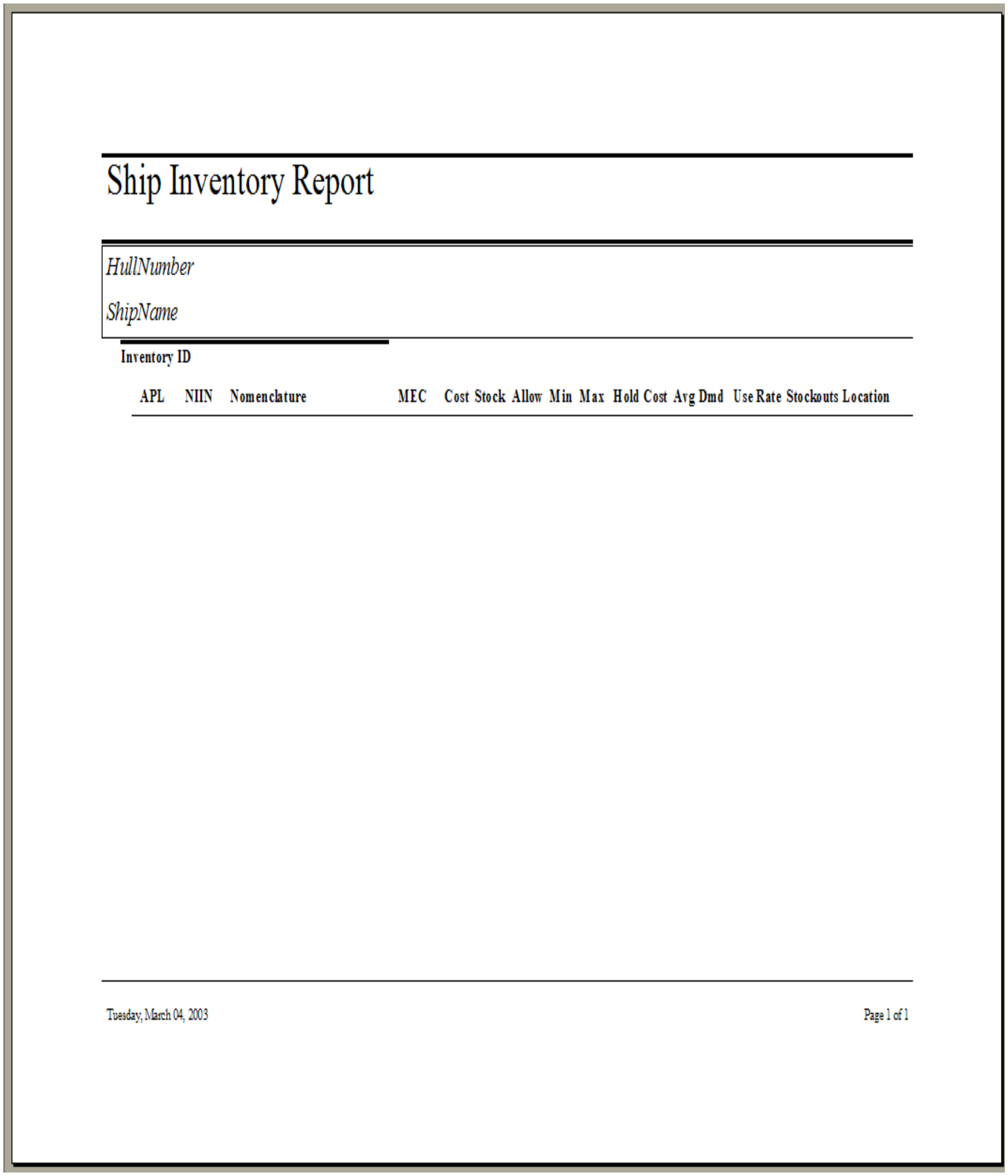
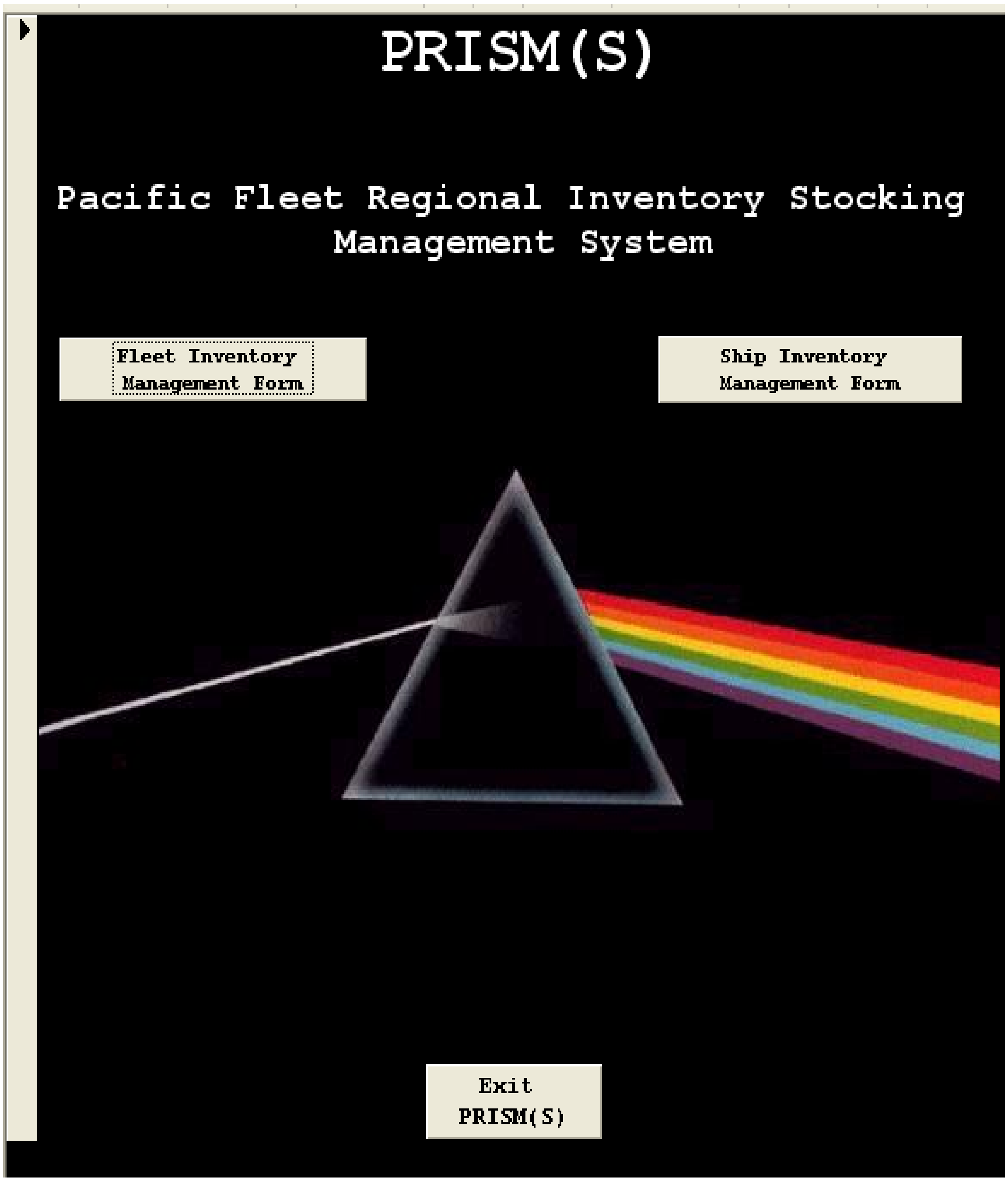


Figure 16: Microsoft Access Privilege Matrix for PRISM(S) Database

Subject	Fleet Inventory	Ship Inventory
Admin	Full Control	Full Control
Fleet	Write	Write
Ship	Read	Write
Supply	Read & Add	Add
User		Read

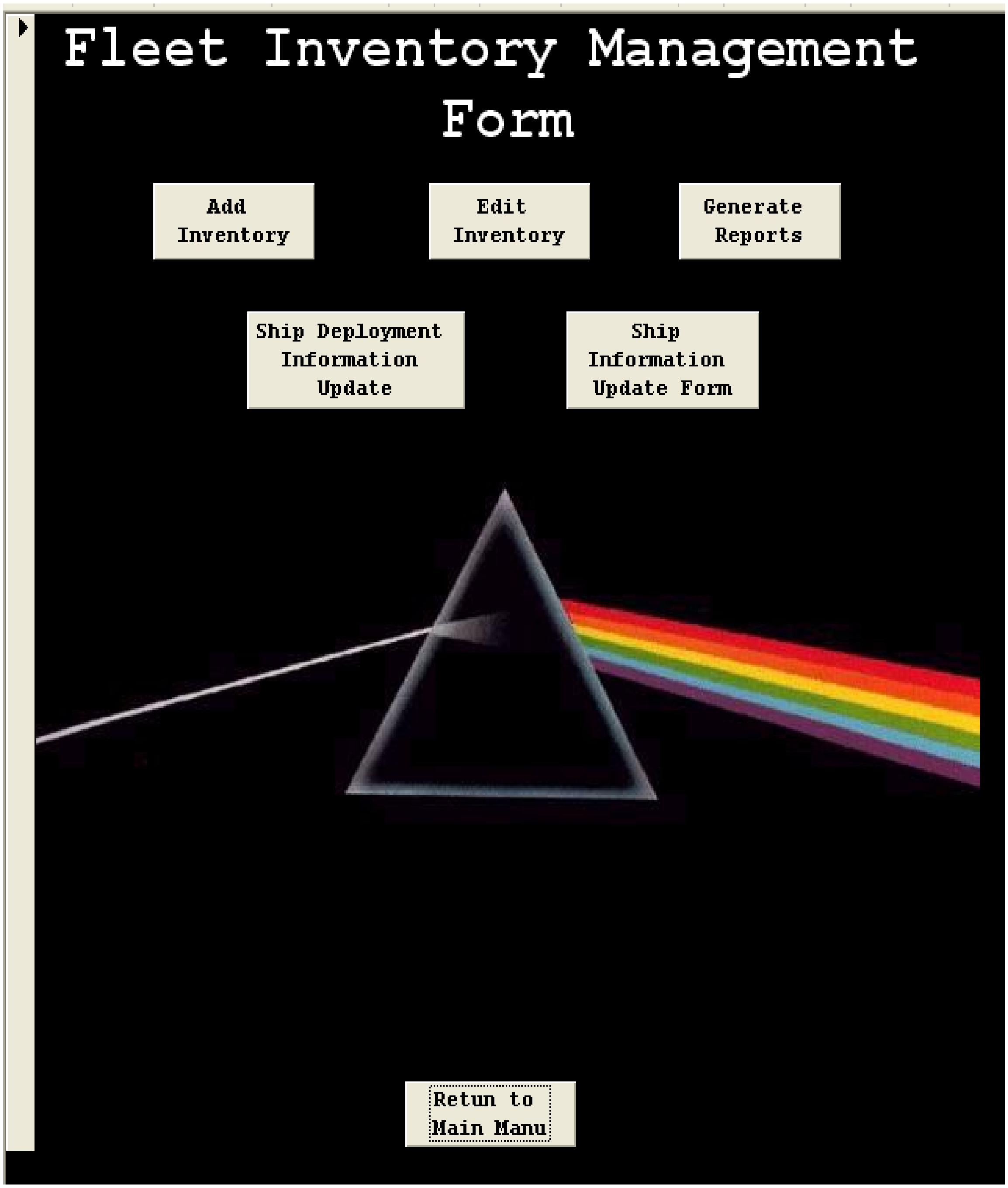
Fleet Forms

Figure 17: PRISM Main Menu



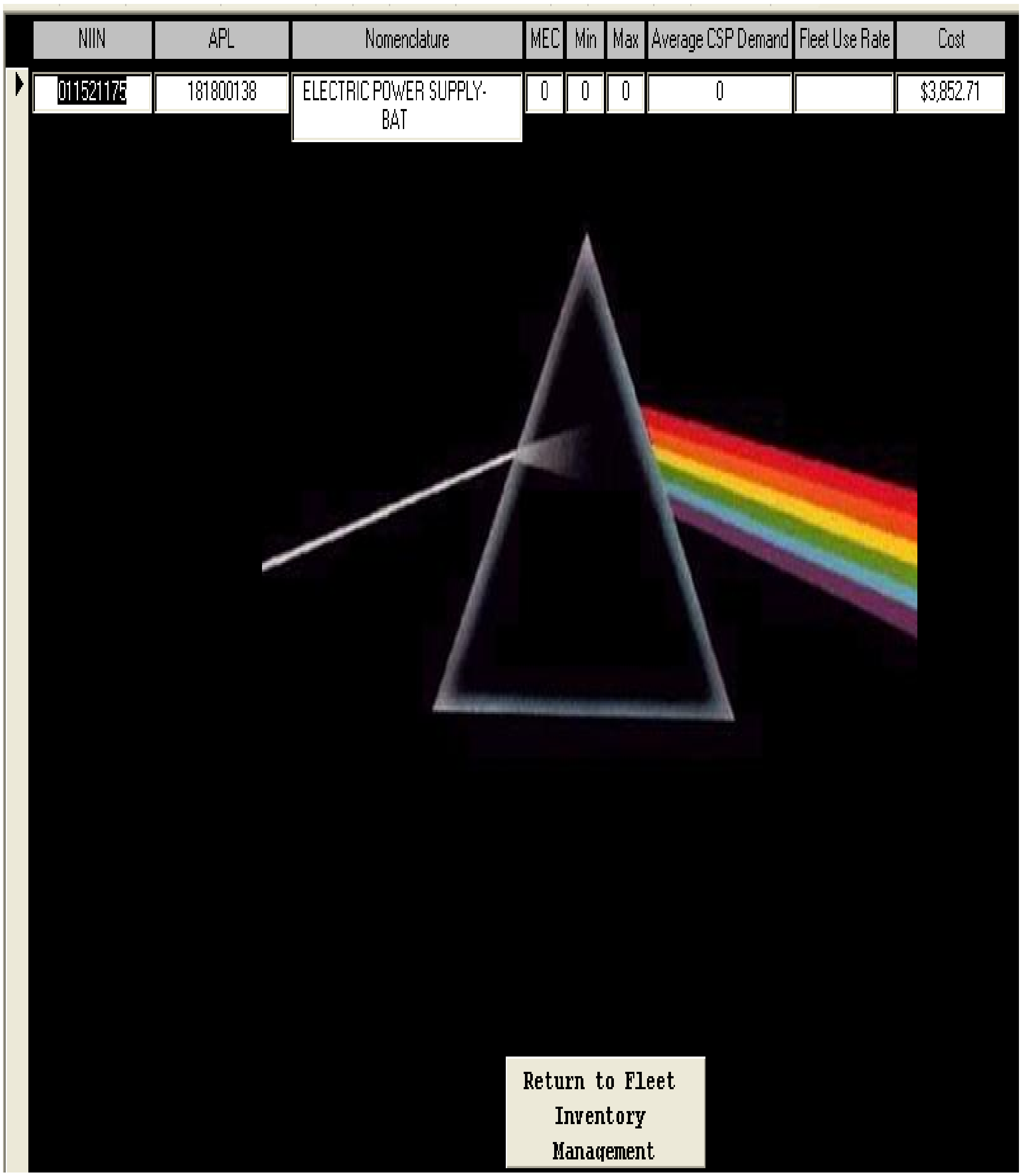
This form is the main menu for the database, acting as the interface where the user can navigate between forms and reports. Functionality is gained through the user of control buttons as seen above. Security functions are implemented where a fleet user will have access to the fleet quadrants, likewise the ship user will have access to the ship quadrants. The following forms depict the fleet forms, followed by the user forms.

Figure 18: Fleet Inventory Management Form



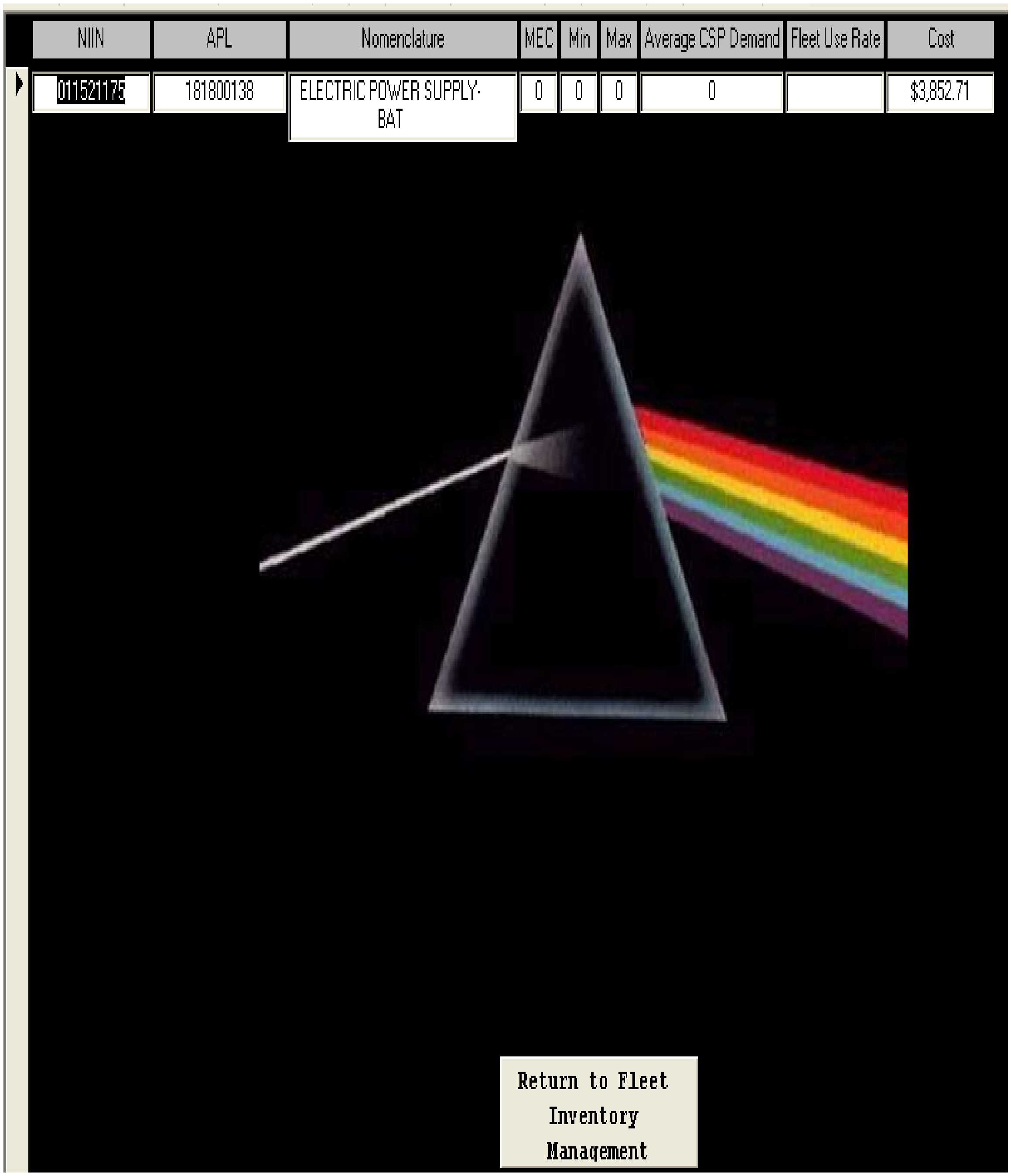
Upon entry into the system, the fleet DBA will arrive at this form. Here, five specific functionalities exist which will help the DBA appropriately configure his data. Each control button sends the user to the specific form or report. The add inventory control button from is shown next.

Figure 19: Master Parts List Input Form



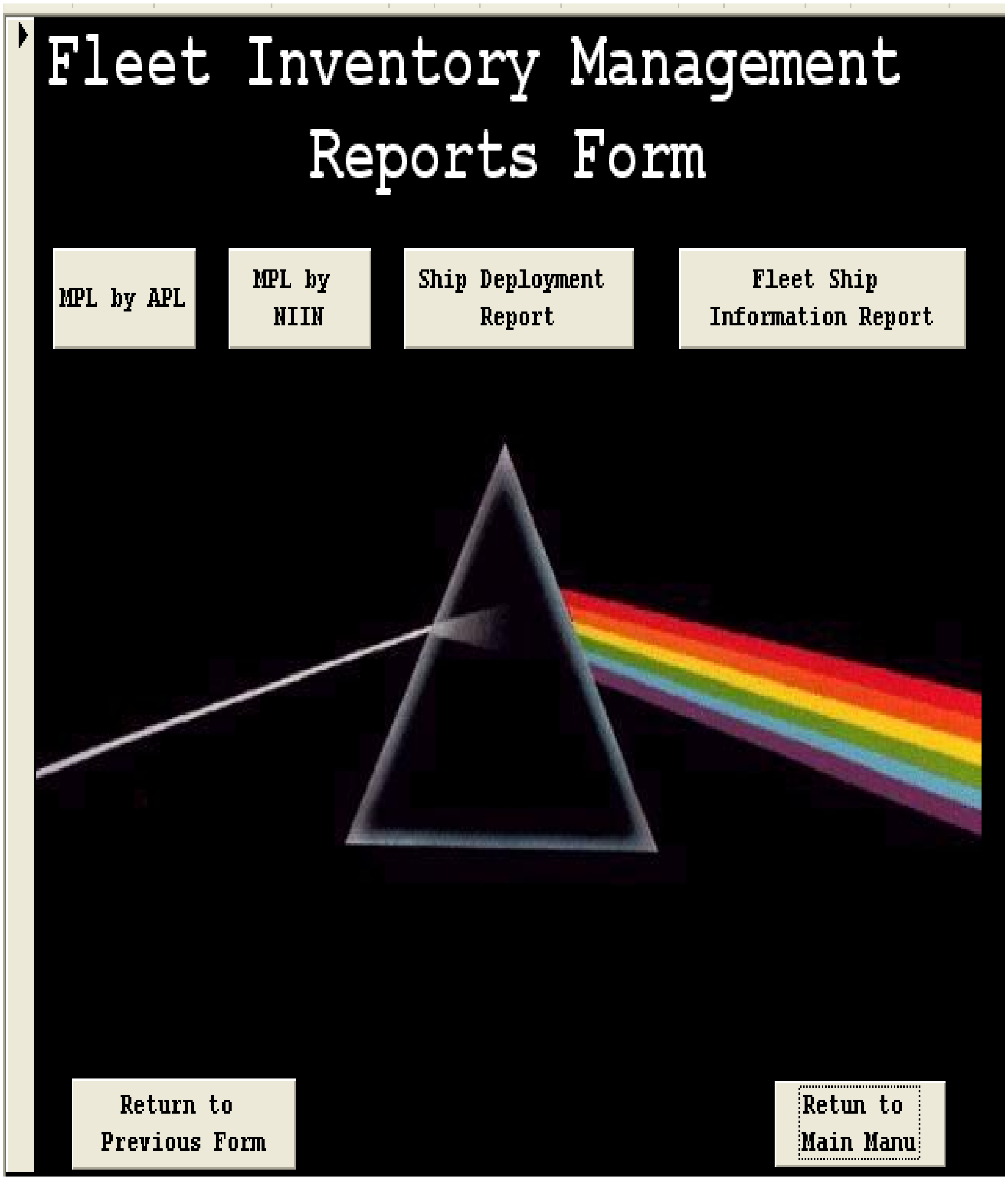
Upon clicking on the add inventory control button, the user enters this form, which allows the fleet DBA to add, remove or edit new part information as it arrives into NAVICP. This form will only be utilized by the DBA as to ensure the security and relevance of the data. The Master Parts List will host relevant information for every part within CSP. The listed inputs above identify specific to each part. The edit inventory form is next.

Figure 20: Master Parts List Update Form



Upon clicking on the edit inventory control button, the user enters this form, which allows the fleet DBA to edit current part information that exists in the Master Parts List. The difference between these two forms is that some of the functionality has been removed from this form to prevent the user from making a mistake that may affect the MPL (POLP concept). This form will only be utilized by the DBA as to ensure the security and relevance of the data. The listed inputs above identify specifics to each part. The ship deployment information update form is next.

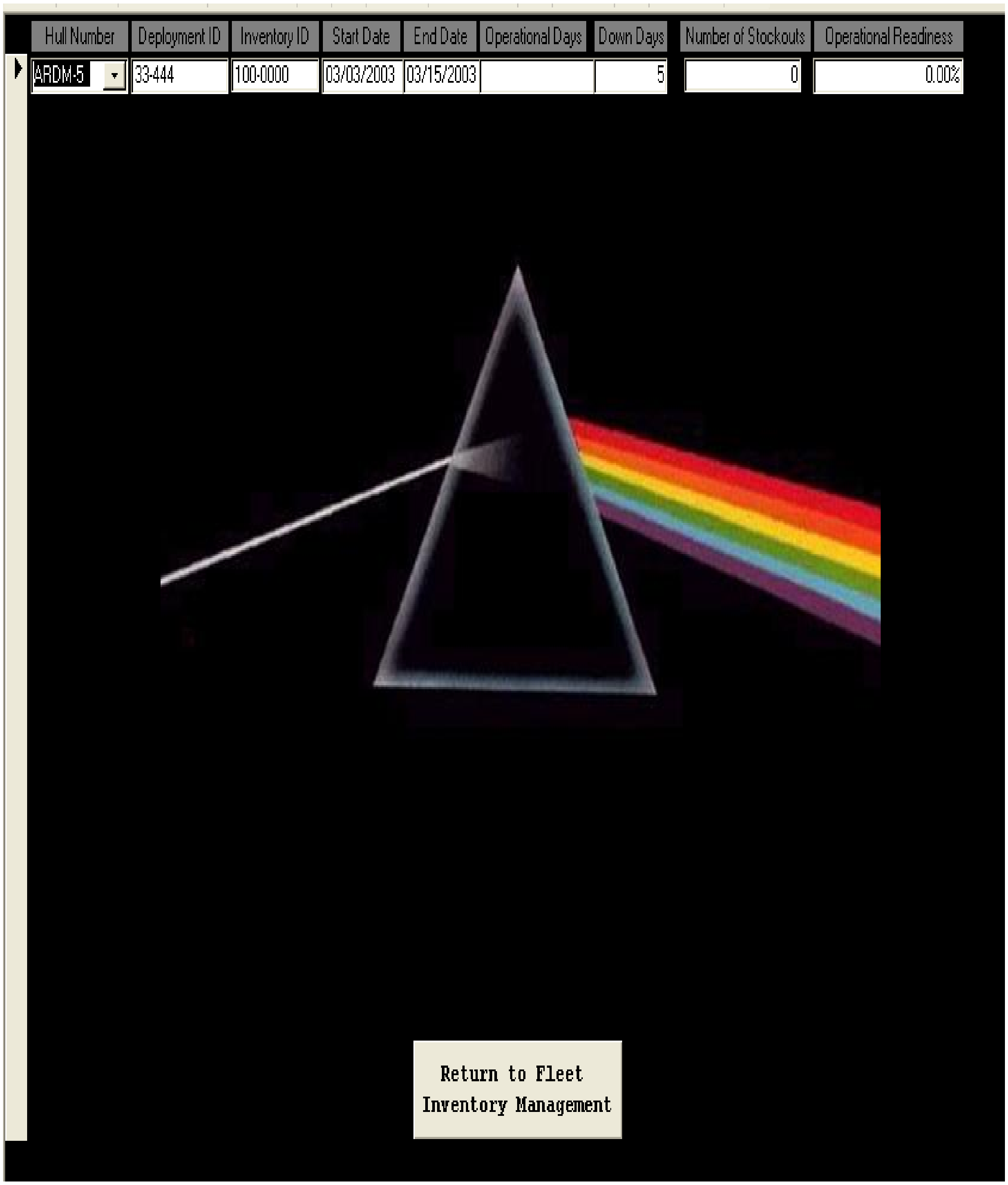
Figure 21: Fleet Inventory Management Reports Form



This form allows the fleet DBA to aggregate the data he desires and print a report based on his specifications. Each specific report will be described in the reports section.

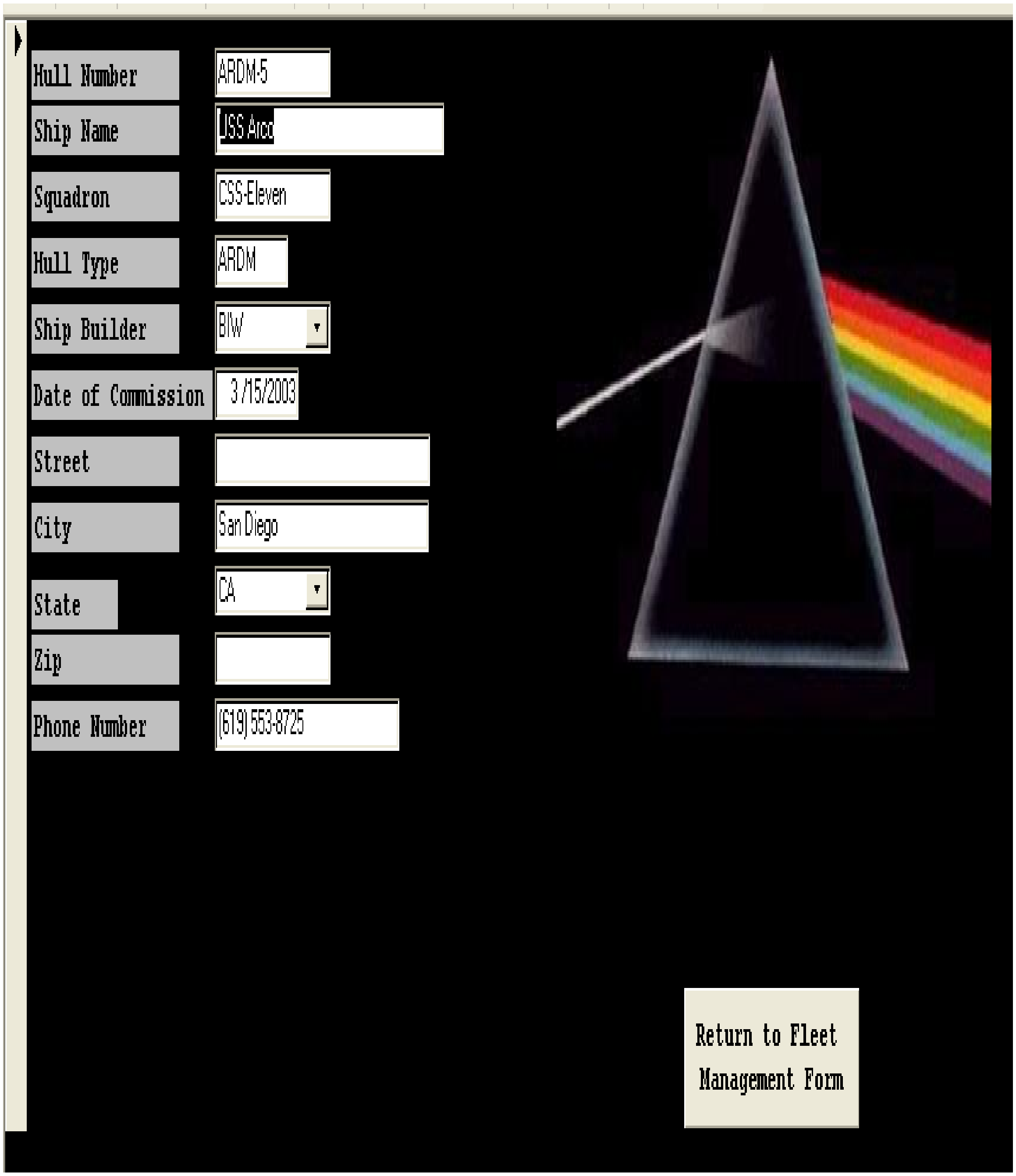
Ship Forms

Figure 22: Ship Deployment Information Update Form



This form gives the fleet DBA a concise deployment history of the particular boat. The DBA can retrieve specifics such as operational days the ship was deployed and compare that number to the amount of down days due to inventory stockouts, and how it ultimately affected readiness. This information will help the manager determine what measures must be taken to increase readiness, and see which parts were problematic. The ship information input form is next.

Figure 23: Ship Information Input Form

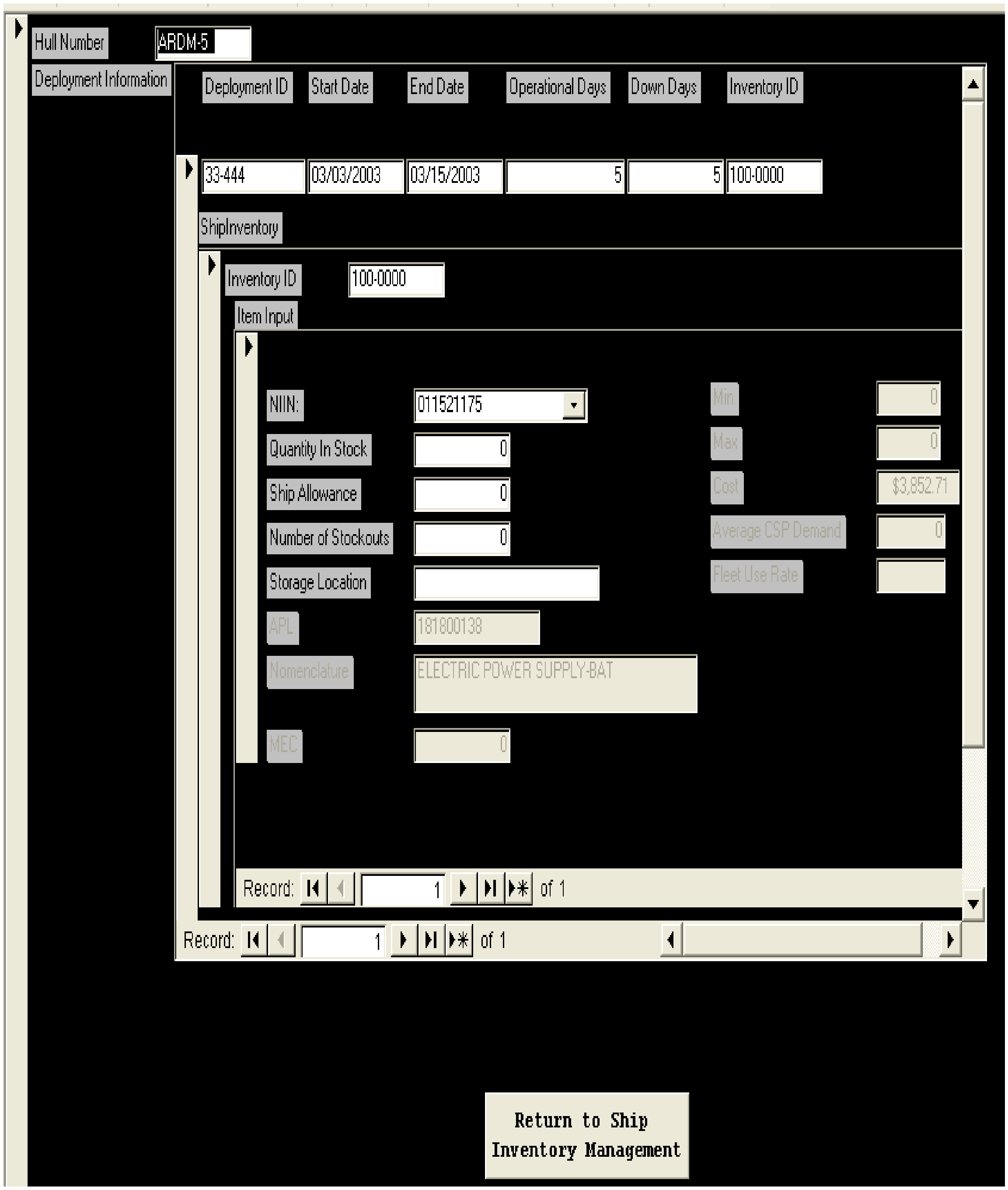


This form allows the DBA to input or update ship information in case of a port change or recent commissioning/de-commissioning. We will now focus on forms specific to the ship user. The first form is the Fleet Inventory Management Form.

Figure 24: Fleet Inventory Management Form

This form allows the ships DBA to access either forms or reports to edit or retrieve data. This is the entry form off the PRISM main menu. The next form is the Ship Deployment Inventory Update Form.

Figure 25: Ship Deployment Inventory Update Form



This form allows the ship DBA to update inventory received after a replenishment period. The importance here is that the information generated identifies specific parts that were in need of replenishment that caused a stockout and pulled the boat off station. The gathered information can be analyzed to see where inefficient stocking levels may exist and signal to NAVICP an indicator for change.

Fleet Reports

Figure 26: Master Parts List by APL Report

Master Parts List by APL Report

APL: 00003063

MEC	NIIN	Nomenclature	Min	Max	Cost	Avg CSP Demand	Fleet Use Rate
0	013106171	NANCY	0	0	$2,245.00	0	
2	002952847	NANCY	0	0	$352.38	0	

APL: 00022940

MEC	NIIN	Nomenclature	Min	Max	Cost	Avg CSP Demand	Fleet Use Rate
1	010466283	AN/BQQ-5( )( ) SONAR SYST	1	2	$5,869.00	0	1

APL: 00037785

MEC	NIIN	Nomenclature	Min	Max	Cost	Avg CSP Demand	Fleet Use Rate
0	LLH843604	RADIO	0	0	$8,226.00	0	

APL: 00039180

MEC	NIIN	Nomenclature	Min	Max	Cost	Avg CSP Demand	Fleet Use Rate
1	LLH7A0819	JOINT MARITIME COMMAND IN	0	5	$4,312.00	0	1

APL: 00039706

MEC	NIIN	Nomenclature	Min	Max	Cost	Avg CSP Demand	Fleet Use Rate
1	014800394	RADIO	2	8	$24.00	5	3

APL: 0-005750131

MEC	NIIN	Nomenclature	Min	Max	Cost	Avg CSP Demand	Fleet Use Rate
0	013173555	WEAPON SYSTEM-MK36 TOMAHA	0	0	$874.73	0	

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This report provides the user with information concerning all parts associated with a specific APL. An APL is specific piece of equipment that may have multiple parts associated. For example, a generator might have a casing, brushes, bearings and connectors all required for operation. If one bearing seizes, the piece of equipment is broken until the new bearing is replaced. A NAVICP officer can pull the report of exactly which parts constitute this specific piece of equipment.

Figure 27: Master Parts List by NIIN

Master Parts List by NIIN Report

NIIN: 002952847

MEC	APL	Nomenclature	Min	Max	Cost	Avg CSP Demand	Fleet Use Rate
2	00003063	NANCY	0	0	$352.38	0	

NIIN: 003730097

MEC	APL	Nomenclature	Min	Max	Cost	Avg CSP Demand	Fleet Use Rate
3	040280056X	CONDENSING SYSTEM-MAIN CO	1	2	$17.98	1	0

NIIN: 003788557

MEC	APL	Nomenclature	Min	Max	Cost	Avg CSP Demand	Fleet Use Rate
4	882234201	HYDRAULIC CONTROL-MAIN X	0	0	$168.29	0	

NIIN: 003872587

MEC	APL	Nomenclature	Min	Max	Cost	Avg CSP Demand	Fleet Use Rate
5	154401598	ELECTRIC POWER SUPPLY-BAT	1	2	$167.18	1	

NIIN: 004129206

MEC	APL	Nomenclature	Min	Max	Cost	Avg CSP Demand	Fleet Use Rate
1	2-320024503	SECURITY	1	3	$93.13	1	1

NIIN: 004691855

MEC	APL	Nomenclature	Min	Max	Cost	Avg CSP Demand	Fleet Use Rate
1	882100001	REFRIGERATION-SHIP STORES	15	22	$21.36	10	12

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This report does much the same as the previous except it looks up the specific part by its NIIN rather than by the APL. This just shows the flexibility that we have created within PRISM. We have attempted to cater to the user through the functional blueprinting process.

Figure 28: Fleet - Ship Deployment Report

Ship Deployment Report

Hull Number: *ARDM-5* ***Ship Name:*** *USS Arco*

DeploymentID *33-444*

Ship Inventory ID 100-0000

Start Date	End Date	Operational Days	Down Days	Operational Readiness Percentage
03/03/2003	03/15/2003	5	5	0.00%

Hull Number: *DSRV-2* ***Ship Name:*** *USS Avalon*

DeploymentID *03-25*

Ship Inventory ID 2-1

Start Date	End Date	Operational Days	Down Days	Operational Readiness Percentage
12/25/2002	01/05/2003	10	0	100.00%
12/25/2002	01/05/2003	10	0	100.00%
12/25/2002	01/05/2003	10	0	100.00%

Hull Number: *SSN-773* ***Ship Name:*** *USS Cheyenne*

DeploymentID *03-11*

Ship Inventory ID 773-20

Start Date	End Date	Operational Days	Down Days	Operational Readiness Percentage
05/02/2003	06/08/2003	22	1	95.45%
05/02/2003	06/08/2003	22	1	95.45%

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This report consolidates ship deployment records so the user can tailor a brief for his audience. For example, if a Squadron Commodore briefs his Admiral, he can select which boats he would like to brief and obtain the listed data. The fleet DBA can tailor the information to meet the briefer's requirements.

Figure 29: Fleet - Ship Information Report

Ship Information Report

HullNumber	Ship Name	Squadron	Hull Type	Ship Builder	Date of Commission	Street	City	State	Zip	Phone Number
ARDM-5	USS Arco	Eleven	ARDM	BIW	3/15/2003		San Diego	CA		(619) 553-8725
AS-40	USS Frank Cable	Fifteen	AS					GU		(671) 339-4006
DSRV-1	USS Mystic	Five	SSN					CA		(619) 553-7088
DSRV-2	USS Avalon	Five	DSRV					CA		(619) 553-7088
SSBN-726	USS Ohio	Nine	SSBN				Silverdale	WA		(360) 396-4211
SSBN-727	USS Michigan	Nine	SSBN				Silverdale	WA		(360) 396-4211

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This report provides the user with a consolidated look at the entire fleet of submarines. A good tool for the Commodore, he can easily view the listed information.

Ship Reports

Figure 30: Ship Inventory Report

Ship Inventory Report

HullNumber **Ship Name:**

Inventory ID

MEC	NIIN	APL	Nomenclature	Stock Qty	Allow	Min Max	CSP Dmd	Use Rate	Cost	Hold Cost	Stockouts	Location

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This report gives the Supply Officer an aggregate listing of parts by Hull Number. Upon entering this report, the Safety Officer must specify (input) the boats name or hull number and the report selects the information from the on hand MPL and dispenses the report in the aggregate.

Figure 31: Ship Inventory Report by Inventory ID Number

By Inventory ID Ship Inventory Report

HullNumber *ARDM-5* *Ship Name:* *USS Arco*

Inventory ID 100-0000

MEC	NIIN	APL	Nomenclature	Stock Qty	Allow	Min	Max	CSP Dm	Use Rate	Cost	Hold Cost	Stockouts	Location
0	011521175	181800138	LECTRIC POWER SUPPLY-BA	0	0	0	0	0		$3,852.71	$0.00	0	

HullNumber *DSRV-1* *Ship Name:* *USS Mystic*

Inventory ID 1-1

MEC	NIIN	APL	Nomenclature	Stock Qty	Allow	Min	Max	CSP Dm	Use Rate	Cost	Hold Cost	Stockouts	Location
5	003872587	154401598	LECTRIC POWER SUPPLY-BA	5	5	1	2	1		$167.18	$835.90	5	ARCL

HullNumber *DSRV-2* *Ship Name:* *USS Avalon*

Inventory ID 2-1

MEC	NIIN	APL	Nomenclature	Stock Qty	Allow	Min	Max	CSP Dm	Use Rate	Cost	Hold Cost	Stockouts	Location
0	006896437	990990502S	AS GENERATION-OXYGEN PL	1	1	0	0	0		$3.10	$3.10	0	FRCL

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This report does the same thing as the one above, however the lookup is via the inventory ID number. The advantage to this is that if the Supply Officer wants to view only the parts that came on during replenishment, to diagnose if there are stockout issues associated with any particular part, he can do by limiting the search to just the inventory ID. The only parts that will display on the report are those issued for that ID number.

Figure 32: Ship Information Report

Ship Information Report

HullNumber: ARDM-5 **Ship Name:** USS Arco

Squadron	Hull Type	Ship Builder	Date of Commission	Street	City	State	Zip	Phone Number
Eleven	ARDM	BIW	3/15/2003		San Diego	CA		(619) 553-8725

HullNumber: AS-40 **Ship Name:** USS Frank Cable

Squadron	Hull Type	Ship Builder	Date of Commission	Street	City	State	Zip	Phone Number
Fifteen	AS					GU		(671) 339-4006

HullNumber: DSRV-1 **Ship Name:** USS Mystic

Squadron	Hull Type	Ship Builder	Date of Commission	Street	City	State	Zip	Phone Number
Five	SSN					CA		(619) 553-7088

HullNumber: DSRV-2 **Ship Name:** USS Avalon

Squadron	Hull Type	Ship Builder	Date of Commission	Street	City	State	Zip	Phone Number
Five	DSRV					CA		(619) 553-7088

HullNumber: SSBN-726 **Ship Name:** USS Ohio

Squadron	Hull Type	Ship Builder	Date of Commission	Street	City	State	Zip	Phone Number
Nine	SSBN				Silverdale	WA		(360) 396-4211

HullNumber: SSBN-727 **Ship Name:** USS Michigan

Squadron	Hull Type	Ship Builder	Date of Commission	Street	City	State	Zip	Phone Number
Nine	SSBN				Silverdale	WA		(360) 396-4211

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This is the same report as seen in the fleet section. A concise report that allows the Supply Officer or CO the location, phone number, address, etc… of the boats he is interested in.

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